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A MONOGRAPH

OF THE

TSETSE-FLIES

[GENUS GLOSSINA, WESTWOOD]

BASED ON THE COLLECTION IN THE BRITISH MUSEUM

BY

ERNEST EDWARD AUSTEN

WITH

A CHAPTER ON MOUTH-PARTS

BY H. J. HANSEN, PHIL. DOC.

LONDON

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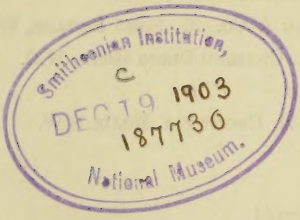

PREFACE.

The Trustees of the British Museum have authorised the preparation and publication of the present work in view of the great practical importance of an accurate knowledge of the genus of flies to which Wiedemann gave the name Glossina. The discovery by Colonel Bruce of the fact that the common Tsetse-fly of South Africa produces the death of horses and cattle rightly ascribed to its attacks by introducing into the blood of its victims a minute parasite, the *Trypanosoma Brucei*, has been followed by the discovery of similar parasites in the Indian disease known as Surra, in the Mal de Caderas of South America, in the Dourine of Algeria, and, lastly, in the blood of human subjects. The last and most important discovery is that by Castellani of the occurrence of a Trypanosoma in the cerebro-spinal fluid of nearly seventy per cent. of the cases of sleeping sickness examined for this purpose by him at Entebbe, Uganda, in the early part of this year. It is estimated that thirty thousand of the native inhabitants of the Uganda Province have died of the sleeping sickness since its sudden appearance among them two years ago.

We are not yet sufficiently acquainted with the facts as to the distinguishing characteristics of the different species of Trypanosoma concerned in causing these diseases. Nor do we know in any case, excepting that of the Nagana disease, what is the nature of the insect (if insect it be, as is probable) by which the Trypanosoma is introduced into the blood of a previously healthy animal or man. In the case of the Nagana disease, we know that a Tsetse-fly — *Glossina morsitans* of Westwood—is the habitual and specific carrier of the parasite. Even though other blood-sucking insects may occasionally act as intermediaries and pass on the Nagana parasite from one animal to another, it is to *Glossina morsitans*, and possibly also to

G. pallidipes, that the disease owes its prevalence in special localities, and it is apparently these species which Colonel Bruce used in his experiments.

The question immediately arises as to whether the other species of Glossina are carriers of disease germs; and whether other species of Trypanosoma, especially that found infesting the human blood and cavitary fluids, are carried by species of Glossina or Tsetse-fly.

An accurate knowledge of Tsetse-flies is clearly indispensable for further progress in this inquiry.

Inasmuch as the genus Glossina is found only in Africa, it is certain that in India and in South America other carriers of the Trypanosoma must be at work. At present, though it appears that *Stomoxys* and some other "biting flies," not scientifically determined, have been experimentally shown to be *capable* of carrying the Trypanosoma of Surra and of Nagana from one animal to another, no constant association of any genus or species of fly with these Trypanosoma-diseases has been suggested, excepting that of Glossina with the African Nagana disease.

In view of the fact that the Trypanosoma parasite is not observed to undergo any developmental changes within the Tsetse-fly similar to the changes which the malaria-parasite Laverania undergoes in the body of the gnats of the genus Anopheles, it is not unreasonable to suppose that there is no such exclusive bond of association between Glossina and Trypanosoma as there is between Anopheles and Laverania. Other carriers may serve for Trypanosoma, though Laverania must have Anopheles and no other.

On these points we require further observation. Collections from all parts of the world of flies (and other insects) which suck the blood of human beings and other animals are needed, accompanied by careful notes as to habits, locality, and life-history. Such collections will be received with special welcome, and at once investigated if addressed to me, here. It is clear that an accurate and comprehensive study of blood-sucking organisms, in view of their possible action as carriers of disease, has become a matter of the most urgent public importance.

As an illustration of the significance of the discrimination of the different species of blood-sucking flies, I may mention that whilst these lines are in the press, I have received from Colonel Bruce a small box of biting flies taken at Entebbe, Uganda,

where sleeping sickness is now rife. Among these Mr. Austen has determined one horse-fly (*Tabanus* sp. incert.), and ten Tsetse-flies (five males and five females) of the species *Glossina palpalis*, Rob.-Desv.

This particular species of Tsetse-fly is essentially a West African species, known from the Gambia to the Congo. It certainly suggests the need for an inquiry into the possible connection between this fly and the sleeping sickness, when we remember that that disease has been established for years on the West Coast of Africa, but was unknown in Uganda until two years ago. Sir Henry Stanley met with "Tsetse-fly" for a long distance on the Upper Congo, and it is suggested by Mr. Austen that *Glossina palpalis* reaches Uganda by way of the valleys of the Congo and Aruwimi.

E. RAY LANKESTER.

British Museum (Natural History),
Cromwell Road, London, S.W.,
May 15th, 1903.

N.B.—Parcels intended for the Museum should be addressed to The Director, as above, and should be accompanied by a separate letter of advice.

TABLE OF CONTENTS.

PAGE

INTRODUCTION v

CHAPTER

I. THE BIONOMICS OF TSETSE-FIES (GENUS *Glossina*) . . . 1

II. HISTORICAL SURVEY—

I. Bionomic 31

II. Systematic 50

III. SYSTEMATIC POSITION OF THE GENUS 53

IV. SYSTEMATIC DESCRIPTION OF THE GENUS *Glossina* AND ITS SPECIES, WITH NOTES ON THEIR DISTRIBUTION AND HABITS 60

V. THE MOUTH-PARTS OF *Glossina* AND *Stomoxys*. By Dr. H. J. Hansen (Copenhagen) 105

VI. BIBLIOGRAPHY—

PART I.—The Literature of Tsetse-flies 121

PART II.—Tsetse-fly Disease and the *Trypanosoma* of Nagana and Kindred Species 253

VII. APPENDICES—

APPENDIX A.—Abstract of Lieut.-Colonel Bruce's "Further Report on the Tsetse-fly Disease" 268

APPENDIX B.—"A Note on the 'Tse-Tse' Flies of the British Central Africa Protectorate." By Captain Richard Crawshay 287

APPENDIX C.—Copies of Letters on the Subject of the Supposed Connection between the Tsetse and the Buffalo (*Bubalus caffer*, Sparrman); transmitted by the Foreign Office to the British Museum (Natural History) 290

APPENDIX D.—Native Methods of Protecting Animals from the Attacks of Tsetse-flies. Native Prophylactics against and Remedies for Tsetse-fly Disease. Native Names for Tsetse-flies 297

APPENDIX E.—The Geographical Distribution of Nagana, and the Possible Transmission of the Parasite of the Disease by Species of *Glossina* other than *Gl. morsitans*, and by Blood-Sucking Flies other than Tsetse 309

APPENDIX F.—"A Note on the Origin of the word 'Tse-Tse.'" By Captain Richard Crawshay . . 309

APPENDIX G.—The Species of Tsetse found at Entebbe, Lake Victoria, Uganda 309

APPENDIX H.—Trypanosomiasis on the Upper Niger.—A Note by Dr. Cuthbert Christy 310

LIST OF PLATES.

PLATE
I. *Glossina palpalis*, Robineau-Desvoidy. (♂.)

II. *Glossina pallicera*, Bigot. (♂.)

III. *Glossina morsitans*, Westwood. (♀.)

IV. *Glossina pallidipes*, Austen. (♀.)

V. *Glossina longipalpis*, Wiedemann. (♂.)

VI. *Glossina fusca*, Walker. (♀.)

VII. *Glossina longipennis*, Corti. (♀.)

VIII. The Mouth-Parts of *Glossina* and *Stomoxys*.

IX. The Mouth-Parts of *Glossina* and *Stomoxys*.

Map of Africa south of the Sahara, illustrating present knowledge of the distribution of *Glossina* . . . *facing page* 28

NOTE.—In the coloured plates, the *vertical* line indicating size includes the proboscis.

LIST OF FIGURES IN THE TEXT.

FIG.		PAGE
1.	*Trypanosoma brucei*, Plimmer and Bradford, the parasite of Nagana, or Tsetse-fly disease, in blood of donkey (× about 2,500 diameters); from a stained preparation kindly lent by the London School of Tropical Medicine	iv
2.	A Tsetse-fly (*Glossina longipennis*, Corti, from Somaliland), in resting attitude, showing the position of the wings (× 4) .	4
3.	*Stomoxys sp.*, from Natal, in resting attitude, showing the position of the wings (× 4)	5
4.	*Hæmatopota sp.*, from Zululand, in resting attitude, showing the position of the wings (× 4)	6
5.	A Tsetse-fly (*Glossina morsitans*, Westw., ♀), before feeding (× 6)	20
6.	A Tsetse-fly (*Glossina morsitans*, Westw., ♀), after feeding, showing abdomen distended with blood (× 6). From a drawing from life kindly lent by Lieut.-Colonel Bruce . .	20
7.	Pupa of Zululand Tsetse-fly, dorsal aspect (× 12); *a*, posterior extremity, showing pit and right larval stigma, *st* (× 24); *b*, anterior extremity, showing bifurcated longitudinal seam, which opens to permit the escape of the imago (× 8) . .	27
8.	Diagram showing nomenclature of external characters of *Glossina*, used in description	62
9.	Left antenna of *Glossina pallidipes*, Austen, ♂, from the inner side (× 60); *p*, aperture of sense-organ on third joint . .	63
10.	Diagram of thoracic chætotaxy of *Glossina*, dorsal aspect (× 10).	67
11.	Diagram of thoracic chætotaxy of *Glossina*, pleural aspect (× 10)	69
12.	Distal portion of abdomen of *Glossina morsitans*, Westw. (ventral aspect), showing (*h*) hypopygium (× 15)	94
13.	Distal portion of abdomen of *Glossina longipalpis*, Wied. (ventral aspect), showing (*h*) hypopygium (× 15)	94
14.	Dog suffering from Tsetse-fly disease, or Nagana (after Bruce) .	281
15.	Horse suffering from Tsetse-fly disease, or Nagana (after Bruce) .	282
16.	Donkey suffering from Tsetse-fly disease, or Nagana (after Bruce)	284

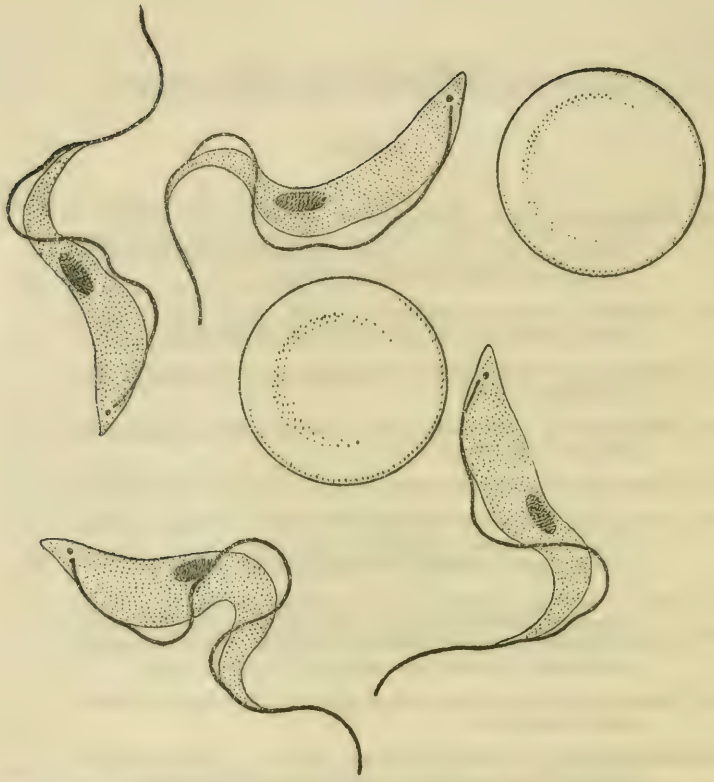

FIG. 1.

Trypanosoma brucei, Plimmer and Bradford, the parasite of Nagana, or Tsetse-fly disease, in blood of donkey (× about 2,500); from a stained preparation kindly lent by the London School of Tropical Medicine.

INTRODUCTION.

More than fifty years have elapsed since Gordon Cumming drew the attention of all who were interested in African travel and adventure to the fatal effects upon horses and cattle of the bite of "the famous fly called 'Tsetse.'" With the publication of successive volumes containing the experiences of explorers, and of elephant-hunters and sportsmen who gradually began to penetrate into what were then the happy hunting-grounds between the Vaal River and the Zambesi, the tale of loss and disaster due to the Tsetse was rapidly swelled; and it was not long before these insignificant-looking insects were recognised as constituting a barrier more formidable to the explorer and the colonist than almost any other. Thus the general interest taken in the genus which forms the subject of this book has never slackened, and "the Tsetse-fly"—for it is a common error to speak as though there were but a single species—is known by name to thousands of people who have no idea as to what a specimen is like.

For a long time the Tsetse was believed to be directly responsible for the havoc caused by its bite, the prevailing opinion being that it elaborated within itself a subtle poison which when injected into domestic animals occasioned their more or less speedy death. It was not until the year 1895 that the brilliant researches of Lieut.-Colonel Bruce, in Zululand, showed that this idea was mistaken, and that the part played by the Tsetse-fly in producing the disease which bears its name was in the main analogous to the rôle of certain mosquitoes in the dissemination of malarial fever among human beings. Bruce proved that the Tsetse is merely the *carrier* of a hæmatozoon or blood-parasite, now known as *Trypanosoma brucei*, Plimmer and Bradford,* which appears to live normally in the blood of many

* "Proceedings of the Royal Society of London." Vol. LXIV. (August 31, 1899), p. 280.

species of wild animals in Africa without doing them any harm, but when taken therefrom and introduced by the proboscis of the Tsetse into the blood of domestic animals multiplies with enormous rapidity, and eventually causes death. Quite recently a similar parasite has been discovered in the blood of man in West Africa, where several species of Tsetse-flies are known to occur. In other parts of the Continent all experience goes to show that the bite of the Tsetse has no ill effect upon man; and though it is not yet known whether a Tsetse is the means of conveying this new parasite which has been found in human blood, the discovery has at least caused the various West African species to be suspected, and has lent these insects a new importance in the eyes of students of tropical medicine.

The present work has been prepared with a view not only to supplying a résumé of our knowledge of the Tsetse-flies, but also in order to enable those who may be engaged in Africa itself upon the investigation of the maladies produced in different animals by the various species of *Trypanosoma*, to determine the species of *Glossina* responsible for the dissemination of the hæmatozoon. The systematic portion of the volume has been a matter of considerable difficulty, owing partly to the remarkable dearth in the genus *Glossina* of structural characters such as might be utilised for the distinction of species, and partly to the faulty condition of the bulk of the material available for examination. Tsetse-flies are generally rare in collections, and so far as regards the number of specimens of these insects in its possession the British Museum would probably compare favourably with any other similar institution. But unfortunately most of the material has been collected by sportsmen unprovided with the necessary materials for its preservation, with the result that owing to the rough and ready methods perforce adopted, there are few specimens in our collection that are not more or less damaged. It would not be too much to say that the specimens representing *Glossina* in the British Museum collection are in poorer condition than those of any other well-known genus of Diptera. In consequence of this, and also of the limited number of specimens from the various localities, no attempt has been made in the systematic portion of this volume to do more than describe the external anatomy of the genus and its different species. The special attention of the reader is, however, directed to Chapter V., in which Dr. H. J. Hansen gives the results of his investigation of the mouth-parts.

It is to be hoped that this Monograph will at least have the result of inducing those who have the opportunity to collect Tsetse-flies for the British Museum, pinning some specimens on the spot and preserving others carefully in spirit;* this would enable very necessary dissections to be made of the proboscis and other structures, including the male genitalia. It would be particularly interesting to see whether the specific distinctions described in Chapter IV. are supported by hidden differences in the latter organs.

One new species is described in Chapter IV., and, with the exception of the type of *Gl. palpalis*, Rob.-Desv., which, as explained in the proper place, is probably no longer in existence, I have been so fortunate as to be able to examine the types of all the other species, so that the correctness of my identifications may consequently be relied upon. To Prof. Fr. Brauer and Herr Josef Bischof, of the K. K. Naturhistorisches Hofmuseum, Vienna; Dr. R. Gestro, of the Museo Civico di Storia Naturale, Genoa; Prof. E. B. Poulton, F.R.S., of the Hope Museum, Oxford; and Mr. G. H. Verrall, of Newmarket, all of whom have with the greatest readiness allowed me to examine the various types in their charge or possession, it is my pleasant duty to express my grateful acknowledgments. My sincere thanks are likewise due to Mr. L. R. Crawshay, who courteously allowed me to examine a series of specimens of different species collected by his brother, Captain Richard Crawshay, to whom I am indebted for the interesting observations on Tsetse-flies in British Central Africa, printed in Chapter VII., Appendix B.; to Prof. Poulton, who lent me certain specimens of *Glossina morsitans* in the collection of the Oxford Museum, in addition to the types of the three species described by Westwood; and to Dr. K. Grünberg, of the Königliches Zoologisches Museum, Berlin, who most willingly sent for my examination the whole of the Tsetse-material recently collected by Dr. Schilling in Togo-land, West Africa. As a result of my examination of the specimens from Togo, I have been able to show that the true *Glossina morsitans*, Westw., occurs in that country, which was hitherto unknown. Whether or not *Trypanosoma brucei*, the parasite of Tsetse-fly disease, is capable of being conveyed from animal to animal by species of *Glossina* other than this has yet

* For directions as to the way in which Tsetse-flies should be collected, see the author's pamphlet,—"How to Collect Diptera (Two-Winged Flies),"—issued by the British Museum (Natural History).

to be proved; but the importance of the occurrence of *Gl. morsitans* (in addition to other species of Tsetse) in Togo is obvious in connection with the fact that Tsetse-fly disease (called Surra by German writers) has also been shown to exist there.

Before closing my list of acknowledgments, a word of special thanks is due to my artist, Mr. A. J. Engel Terzi, for the unremitting care and attention bestowed by him upon the coloured plates. Mr. Terzi's beautiful drawings have been well reproduced by Messrs. Carl Hentschel & Co., with the result that the reader now has the advantage of possessing accurate representations of Tsetse-flies, such as have not hitherto been available. I have also to thank Mr. Terzi for the trouble that he has taken over the drawings for the figures that illustrate the text. To Dr. L. W. Sambon I am indebted for references to certain papers dealing with Tsetse-fly disease, as well as for kind assistance in other ways; while I have to thank my uncle, Dr. T. P. Smith, for the preparation of the Index to this volume. Last, but by no means least, I have to express my gratitude to Dr. H. J. Hansen, of Copenhagen, who furnished within a very brief period the valuable account of the mouth-parts in *Glossina* and *Stomoxys* contained in Chapter V., in addition to preparing the admirable drawings reproduced on Plates VIII. and IX. I can but consider myself fortunate in having secured the co-operation of so painstaking and accomplished an investigator, who had previously paid special attention to the mouth-parts of Diptera, and is already well-known owing to his work on the subject.

In the first portion of the "Bibliography" (Chapter VI.) it was deemed advisable in most cases to quote the actual passages *in extenso* in addition to giving references, since the majority of the volumes referred to are out of print or otherwise inaccessible to ordinary students, not to speak of those who may use this book in outlying portions of the Empire. The "Bibliography" cannot, unfortunately, lay claim to anything like completeness. It was thought necessary that this volume should be published with as little delay as possible, and to have consulted *all* the books on Africa south of the Sahara, not to speak of the Proceedings of Foreign Geographical Societies, in which no doubt many valuable notes lie buried, would have entailed many months' more work. Such as it is, however, it is to be hoped that a perusal of the "Bibliography" will give the reader a fairly good idea of the bionomics and distribution of Tsetse-

flies, as well as of the practical effects of their attacks. If, as seems likely, the Tsetse in Southern Africa, at any rate, is destined to become extinct with the big game and the northward spread of civilisation, the records of earlier struggles with the pest of the pioneer and elephant-hunter will at least possess a historic interest, when the railway-train and the traction-engine have largely superseded the ox-waggon, and the building of the promised hotel at the Victoria Falls has become an accomplished fact.

ERNEST E. AUSTEN.

British Museum (Natural History),
London, S.W.

March 16, 1903.

A.

MONOGRAPH OF THE TSETSE-FLIES.

(Genus *GLOSSINA*, Wied.)

CHAPTER I.

THE BIONOMICS OF TSETSE-FLIES (GENUS *GLOSSINA*).

Although a fairly good idea of the Bionomics of Tsetse-flies may be gained from a perusal of the Bibliography and Appendices to the present work (Chapters VI. and VII.), it will probably be more useful and convenient to the reader to give a short résumé of our knowledge of this subject in a single chapter. At the outset, however, a word of explanation is necessary as to the use of the term "Tsetse." * Since the insects which form the subject of this Monograph were first encountered by Englishmen in the vicinity of the Limpopo, the word Tsetse was

* The form here given, which is employed throughout this book, is the most usual one; but the following variants in spelling are also used by different authors: Tsétsé, Tse-tse, Tsetze, Tse-tsi, Tzetse, Tzetze, Tzee-tzee, Tetse, Sētsé (Major Vardon). There can, of course, be no doubt that the word is onomatopoetic, and, if used originally for *Glossina*, that it owes its origin to the peculiar buzzing sound made by the fly on the wing or when commencing to suck blood. But, in spite of many endeavours, I have so far failed to discover with certainty whether it belongs to the language of one of the South African Bantu tribes, or was invented by the Boer "Voortrekkers" on coming in contact with the fly for the first time after crossing the Vaal River between 1835 and 1837. Since the fly was first met with (by English hunters, at any rate—see Chapter II.) in the vicinity of the Limpopo, it might be supposed that the word Tsetse is Matabeli or Zulu, but I have been unable to find out whether this is so. Gordon Cumming, the earliest English writer to use the word, although not the first British sportsman to meet with the fly, merely speaks of "the fly called 'Tsetse'"; further on in the same volume he describes an encounter with "the famous fly called 'Tsetse.'" Vardon and Oswell, who procured the actual specimen described by Westwood under the well-known name *Glossina morsitans*, are equally reticent as to the origin of its ordinary designation, and all subsequent writers have been content to use the word

originally used by them to mean *Glossina morsitans*, and that species alone. Even at the present day it is still so used by the majority of people interested in African problems, who are unaware of the existence of more than one species of *Glossina*. For a long time, indeed, while "the Dark Continent" was no mere figure of speech, and a trip to the Victoria Falls was looked upon as a journey into "the Far Interior," *Glossina morsitans* remained the only species known by practical experience, or to any but entomologists. With the opening up of Africa, however, people have encountered other species of *Glossina*, and, recognising their similarity to or perhaps not distinguishing them from *Gl. morsitans*, have spoken of them as "the Tsetse," or "the Tsetse-fly." Thus, although it is a fact that certain writers have used the phrase "the true Tsetse-fly," apparently with the intention of distinguishing *Gl. morsitans* from its congeners, the word Tsetse has in recent years undoubtedly come to be employed in a *generic* rather than a *specific* sense, and it is in a generic sense that it will be used in the present work. It is true that we have yet to discover whether all the species of *Glossina* are capable of conveying the hæmatozoon of Tsetse-fly disease, or whether this baleful distinction belongs to *Gl. morsitans* alone.* But the species of the genus differ so markedly from other blood-sucking flies in various details of external structure, as well as in their appearance (due to the mode of

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in one or other of its forms without offering any explanation. Standard dictionaries of the English language complacently label the word "native name," and proceed to give a short description of the fly. I am indebted to my friend and colleague Mr. R. Campbell Thompson, of the Department of Egyptian and Assyrian Antiquities, British Museum, for the nearest approach to a solution of the question yet achieved. After searching through a number of African vocabularies, Mr. Thompson writes as follows:—"W. H. J. Bleek's 'Languages of Mozambique' (1856) gives a comparative table of African dialects, and under 'fly' are the following (the name of the dialect in each case is given in brackets):—(Sofala) *Tundsi;* (Tette) *Sénse;* (Sena and Quilimane) *Tsénse.* I think the last probably solves the mystery, as the letter *n* is so constantly assimilated." It is therefore possible that a native word, which perhaps originally signified *any* fly, eventually, in the valleys of the Zambesi and the Limpopo, came to be *specially* applied, by the natives themselves, to the genus *Glossina;* just as among Englishmen in South Africa at the present day the Tsetse is commonly spoken of as "the fly." On the other hand, the earliest English and Dutch hunters to penetrate into the Waterberg and Zoutpansberg, on being told by their Kafir boys that the unfamiliar insect which was persecuting their trek-oxen and horses was "Tsetse," may have merely received from them the native equivalent for "a fly."

* See Chapter VII., Appendix E., p. 300.

carrying the wings) when at rest, that it is impossible to speak of a particular species as "the Tsetse" or "the true Tsetse-fly" in contra-distinction to the others. It follows, therefore, that the designation Tsetse, in default of a vernacular term for each species of *Glossina*, must be taken as the equivalent of the genus rather than of any one species, even the one which is best known.

General Characters of Tsetse: how to distinguish them from other flies.

A technical description of the genus *Glossina* and of the species (seven in number) at present known will be found in Chapter IV., so that it is here only necessary to characterise Tsetse-flies in simple language, in such a way as to enable a non-entomological reader to recognise a specimen at sight. Tsetse, then, may be described as ordinary-looking sombre brownish or greyish-brown flies, varying in length from $3\frac{1}{2}$ to $4\frac{2}{3}$ lines ($7\frac{1}{2}$ to 10 millimetres) in the case of *Glossina morsitans*, to about $5\frac{1}{2}$ lines ($11\frac{1}{2}$ millimetres) in that of *Gl. fusca* or *longipennis*,* with a prominent proboscis in all species. The hinder half of the body, or abdomen, in the best-known species, though not in all, is of a paler colour and marked with sharply defined dark brown bands, which are interrupted on the middle line; the abdomen, however, is invisible when the insect is at rest, as it is then concealed by the wings. The sexes of Tsetse-flies can readily be distinguished when specimens can be examined, since in the male the external genitalia form a conspicuous knob-like protuberance (hypopygium) beneath the end of the abdomen (see Figs. 12 and 13, p. 94), which is absent in the female.

It is probable that only those who have suffered from the attacks of Tsetse can recognise them when on the wing, but *in the resting position* their identification is easy. In this attitude they can be distinguished from all other blood-sucking Diptera,† especially from those belonging to the genera *Stomoxys* (Fig. 3) and *Hæmatopota* (Fig. 4), which are most likely to be mistaken for them, by the fact that the brownish *wings lie closed flat over one another down the back*, like the blades of a pair of scissors,

* These measurements are only from the head to the end of the body, and are exclusive of the proboscis, which projects horizontally in front of the head, and has a length of about a line to a line and a half, according to the species. In the crossed lines on the coloured plates, however, the vertical line indicates the average length of the whole insect, *including the proboscis*, the transverse line showing the wing-expanse.

† Except *midges*, which, however, need not be considered since they cannot be confused with Tsetse-flies.

while *the proboscis* (i.e. the proboscis enshcathed in the palpi) *projects horizontally in front of the head* (see Fig. 2). As pointed out by Col. Bruce, the closed wings thus give the fly "an elongated appearance" (*Cf.* Chapter VII., Appendix A, p. 271; see also 55, 76, 119, 152, 161).* Measured from the tip of the proboscis to the end of the closed wings the length of *Glossina morsitans* is about half an inch; that of *Gl. fusca* about three-quarters of an inch.

Most writers who have attempted a description of the Tsetse

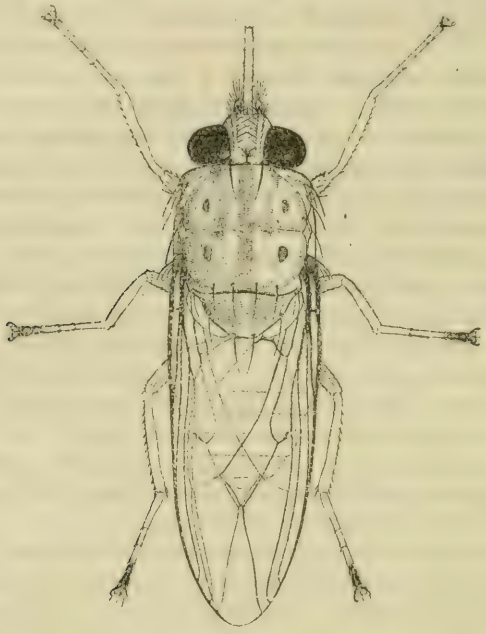

Fig. 2.

A Tsetse-fly (*Glossina longipennis*, Corti, from Somaliland) in resting attitude, showing the position of the wings. (× 4.)

have stated that it is rather larger than the common house-fly, but the comparison is somewhat unfortunate, since few people, other than trained Dipterists, are capable of recognising the true house-fly (*Musca domestica*, Linn.). Moreover, at least two other species of Muscidæ, *Homalomyia canicularis*, Linn., and *Cyrtoneura stabulans*, Fln., are quite common in houses in Europe at certain seasons: the latter of these is considerably larger than

* The numbers refer to the Bibliography (Chapter VI.).

the true house-fly (for which both are no doubt often mistaken), while the former is only about half its size.*

Apart from the prominent proboscis and the mode of carrying the wings when at rest, there is nothing in any way remarkable or striking about the appearance of a Tsetse, and the descriptions of most travellers emphasise this fact. As already mentioned, species of *Stomoxys* and *Hæmatopota* are most likely to be mistaken for *Glossina*, and apart from these confusion can hardly take place. The females of both genera are greedy blood-suckers, and often torment domestic animals very greatly. Of *Stomoxys*, which, as is shown in Chapter III., is a near ally of *Glossina*, several species (all closely resembling, though apparently distinct from, the European *Stomoxys calcitrans*, Linn.) are found in Africa, and in the abdomens of specimens of one of them in the British East Africa Protectorate, the late Captain A. J. Haslam found the *Trypanosoma* of Nagana, or Tsetse-fly disease. Although *Stomoxys* also has a prominent proboscis, it is not ensheathed in the palpi, and is consequently much more slender than the proboscis of *Glossina*. The species of the former genus are little greyish flies with black markings; they are much smaller than Tsetse-flies, and since their wings when in the resting position, instead of closing one over the other, diverge at an angle (see Fig. 3), like those of *Musca domestica*, it is easy to distinguish them. *Hæmatopota*, on the other hand, which is a genus of small horse-flies (Family Tabanidæ) often known as

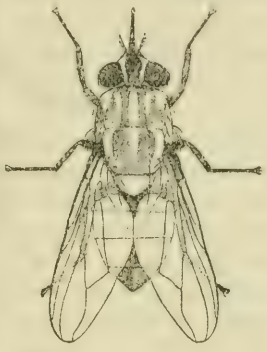

Fig. 3.

Stomoxys sp., from Natal, in resting attitude, showing the position of the wings. (× 4.)

* The average *Musca domestica* in Europe measures about 3 lines (6 to 7 millimetres, or slightly more than a quarter of an inch) in length, and has a wing-expanse of between 7 and 8 lines (from 15 to 16 millimetres); therefore it is in reality decidedly smaller even than a small specimen of *Gl. morsitans*. In the Tropics and hot countries generally *Musca domestica* is usually somewhat smaller than in Europe. The common house-fly justifies its name, for its distribution is now practically world-wide, as it has been carried by ships to all quarters of the globe. As regards South Africa, swarms of house-flies are mentioned by Lichtenstein (Hinrich Lichtenstein: "Reisen im südlichen Africa in den Jahren 1803, 1804, 1805, and 1806" (C. Salfeld: Berlin, 1811), pp. 192–193) as infesting houses near the Karroo, in Cape Colony, in the early years of the 19th century; while *Musca domestica* was at certain seasons one of the pests of our troops in standing camps during the late campaign.

"clegs" in various parts of Great Britain, resembles *Glossina* somewhat closely when at rest. The species of this genus, of which no less than twenty-two have been recorded from various parts of Africa, are of much the same size as the larger Tsetse-flies,* and are of the same brownish colour and elongate shape. In no case, however, is the abdomen marked with dark bands on a light ground, while the wings in the resting position do not close one over the other, but diverge slightly at the tips and are also somewhat *tectiform*, i.e. they meet together at the base like the roof of a house (Fig. 4). The antennæ, too, afford a further

Fig. 4.
Hæmatopota sp., from Zululand, in resting attitude, showing the position of the wings. (× 4.) The wing markings are omitted.

means of distinction. While the antennæ of Tsetse-flies, as of all Muscidæ, are drooping, those of *Hæmatopota* project horizontally in front of the head, and being of some length are readily seen.

Where Tsetse-flies are usually found: their fondness for river banks and the neighbourhood of water, and avoidance of open plains: swarms met with in certain places.

Even in those parts of Africa in which the Tsetse occurs it is not found everywhere, but is confined to definite tracts which are known as "Fly-belts." We are still somewhat in the dark as to the factors that determine the limits of these "belts," but, although the Tsetse is undoubtedly dependent upon the blood of wild animals for its continued

* The average length of an African *Hæmatopota* is 5 lines (11 millimetres); average wing-expanse 11 lines (24 millimetres).

existence, all recent evidence goes to show that the most important element is the physical character of the locality. Thus, Mr. Alfred Sharpe writing from British Central Africa to Lord Lansdowne in 1901, with reference to the special connection which many people have supposed to exist between the Tsetse and the buffalo, states that "what regulates the presence of Tsetse-fly is the description of the country almost as much as the abundance or scarcity of game." (See Chapter VII., Appendix C, p. 295.) As a general rule it may be said that the Tsetse is confined to damp, hot, low-lying localities, either on the borders of rivers or lakes, or at any rate not far from water. Cover in the shape of more or less thick bush or forest is essential, and the fly is not found on open grass plains. In the days when South Africa was still a sportsman's paradise, and the veld in what is now the Orange River Colony was teeming with game of every kind, the early hunters who rode and shot over those plains never met with the Tsetse until, pushing farther afield, they entered the hot, moist kloofs in the valley of the Limpopo.

James Chapman [30], one of the earliest authorities, writing in 1868, states that "the Tsetse-fly is generally found within a few miles of water, in rich sandy ridges near marshy spots, and generally in mopani or mimosa forests." In the Northern Transvaal the Tsetse in some places is found on low hills, and Vardon and Oswell having met with the original specimens of *Glossina morsitans* on the Siloquana Hills (between the Magalaqueen or Nylstroom River and the Limpopo) in 1845, Vardon was led to assert that it is "usually found on hills." Later knowledge, however, does not warrant such a generalisation, although it is true that patches of Tsetse-fly are not always situated in low-lying districts. Thus, while in British Central Africa, according to Sir Harry Johnston [145], the Tsetse-fly is "roughly speaking . . . . absent from any district that is above 3,000 feet in altitude," Captain A. St. H. Gibbons [152] in Northern Rhodesia, in February, 1896, during the wet season, found it very troublesome on high ground to the south of the head-waters of the Nanyate River, at an altitude of 4,110 feet above the sea-level. This, however, must be somewhat exceptional, and it is in hot, moist river-valleys that fly-belts generally occur. In the Jubaland Province of the British East Africa Protectorate, according to Mr. J. W. P. McClellan, "The worst places are damp, dark, and low-lying, shaded chiefly by

the Ndoma Palm." * Similarly in Sierra Leone *Glossina palpalis* occurs in mangrove thickets where streams enter the sea.

It is curious that Sir Harry Johnston [125] should have committed himself to the statement that the Tsetse-fly "appears never to go near the edge of a river," and has "a great dislike to water" [145], since the universal experience of travellers and sportsmen is that precisely the reverse is the case. Thus Mr. F. C. Selous [76], writing in 1881 of the plague of Tsetse-flies along the southern bank of the Zambesi and Chobe, to the westward of the Victoria Falls, states that they are "usually found in great numbers near the river," and that "along the water's edge they are an incredible pest. . . ." Instances to the same effect might be multiplied, but as they are all recorded in the Bibliography it will suffice to refer the reader to the testimony of, among others, Thomas Baines [26] (Tsetse at the Victoria Falls); Sir John Kirk [28], who states that the Tsetse extends along the banks of the Rovuma River for 115 miles; E. C. Hore [78] (Tsetse-fly on the shores of Lake Tanganyika); and Dr. Holub [110] (abundance of Tsetse at the water's edge on the Mo-Njeko River, August 7th, 1886).

Within the limits of a fly-belt, however, Tsetse are not always numerous, and it may happen that only a few specimens are encountered in the course of a day. On the other hand they are often met with in much greater numbers. In the passage already referred to, Selous [76] speaks of the fly "attacking one in a perfect swarm, from daylight to sunset . . . ."; David and Charles Livingstone [27], writing in 1865 of their experience of the Tsetse-fly in a valley to the west of Zumbo, state that the flies "accompany us on the march, often buzzing round our heads like a swarm of bees"; Captain F. F. Carter [66] in 1880 found "Tsetse-fly in thousands" on the site of a large deserted village, near Karema, German East Africa; Selous [86], writing of Mashunaland in 1882, speaks of the Tsetse as "swarming" along the Panyame and Umsengaisi Rivers, and as occurring in another locality "in millions." The late W. M. Kerr [98], describing his experience of Tsetse on the Mukumbra River in 1884, states that "the stifling sultry air was literally alive with the Tsetse-fly, against whose maddening attacks clothes were no protection, our only safeguard being to beat them off with twigs and small branches of shrubs. . . ." M. Édouard Foà gives a similarly graphic account of an

* Chapter VII., Appendix C, p. 294.

encounter with swarms of Tsetse on the Kapotche River, their furious onslaughts rendering it impossible to take a meal, or even to remain seated. Sir Harry Johnston [145] states that in British Central Africa, "on the Mwanza River, an affluent of the Shire nearly opposite to the Katunga, the Tsetse are so numerous that the only domestic animals which can be kept by the natives are fowls." Lastly, to pass for a moment to Somaliland, Mr. C. V. A. Peel [163] who met with Tsetse (*Glossina longipennis*, Corti) in that country in 1895, mentions an occasion when his camels on returning to camp in the evening "were followed by a perfect swarm of Tsetse-fly."

"Fly-belts" and their extent: distribution and limits of Tsetse within these areas.

As stated at the commencement of the preceding section a tract of country in which the Tsetse occurs is termed a "Fly-belt."* Although along the courses of rivers, or in the low country bordering a coast line, fly-belts may extend for hundreds of miles, varying greatly in width according to the nature of the country, it does not follow that Tsetse-flies are to be met with at every point throughout the extent of the belt. More usually they are confined to particular patches of forest or bush, the area of which may be quite small.† Thus, according to Baines [55], "the fly is extremely local, and extensive districts in which it prevails may be passed through by the aid of guides, who know the 'patches' of fly, just as a pilot knows the shoals of an estuary." Mr. J. W. P. McLellan, writing of the Jubaland Province of the East Africa Protectorate, states that "in many places the areas in which fly exist are quite small, possibly only a few hundred yards in extent. . . ."‡ Again, Mr. F. J. Jackson in 1887 found Tsetse "in great numbers in a small patch of thick bush, about a mile and a half long and three-quarters of a mile wide,"§ near Taveita; later he met with it "in considerable numbers in a narrow belt of forest, not more than a mile wide, between Mkonumbi and Witu."§ The limits of these patches or areas, as of the fly-belts themselves, are doubtless defined more or less by the physical characters already alluded to; but, nevertheless, it is often difficult to account for them. Various writers have

* Often spoken of shortly as "the Fly," just as the term "Fly" is also used in the special sense of "Tsetse."

† These small fly-infested areas are themselves termed belts by some writers.

‡ Chapter VII., Appendix C, p. 294.

§ *Ibid*, p. 296.

drawn attention to the fact that Tsetse may abound on one bank of a stream while there are none on the other. According to Andersson [20], "cattle may be seen grazing securely on one side of a river, whilst the opposite bank swarms with the insect." On one occasion, Livingstone [21], during a two months' sojourn on the Chobe River, preserved his cattle by keeping them on the northern bank, where not a single Tsetse was found, although the south bank, "only fifty yards distant," was "infested" by the fly. A graphic description is given by Mr. C. V. A. Peel [163] of his experience in Somaliland in 1895. Mr. Peel writes: "It is an extraordinary sensation coming into a belt of 'fly.' There may be but a tiny river-bed. On one side of it not a fly will be encountered, but walk a dozen feet and they suddenly come buzzing by one in hundreds." The results of an incursion into the "Fly Country" in Zululand are thus described by Lieut.-Colonel Bruce *: "On entering 'Fly Country' one is not left long in ignorance of the presence of the Tsetse. The natives may be seen slapping their naked legs, the dogs bite round, and the horses kick. The Tsetse, however, may be said to be somewhat local in its distribution in the 'Fly Country,' being only met with now and then and in few numbers, until you enter some glade or clear space in the thorns, when suddenly the slapping, biting, and kicking go on with tenfold energy, and you can catch thirty or forty flies in a few minutes."

Just as the worst patches of fly within the limits of a Fly-belt are often sharply defined, so in a large tract infested by Tsetse there may be small areas which for some reason, perhaps owing to their having been cleared of bush, the fly never enters. These spots form veritable harbours of refuge for the traveller who may be compelled to cross the Fly-belt with oxen and horses, since, by travelling at night and taking care to keep the animals within an asylum of this kind during the day, the dangerous zone may be traversed in comparative safety. Thus Selous [121] describes how the forty miles of Tsetse-infested swamp on the western bank of the Loanja River can easily be crossed in three nights, owing to the fact that "there are two islands in the swamp free from 'fly,' to which the oxen can be driven to feed and rest during the day-time."

The reader who may wish to discover what is known of the actual extent of Fly-belts in a particular region must consult the Bibliography, but should be careful to note the dates to which

* *Cf.* Chapter VII., Appendix A, p. 271.

statements refer; since, owing to the opening-up and colonisation of many parts of Africa and the enormous diminution in the numbers of big game, as will be shown in the next section, it by no means follows that the limits of a Fly-belt are the same to-day as they were even a few years ago; while in certain cases the belt itself may have ceased to exist.

The limitation of the Tsetse to "belts" is not so remarkable as might at first sight appear. There can be little doubt that it is due to a characteristic of the Order to which these insects belong, which, though frequently overlooked, is exhibited by the majority of species of Diptera, and has attracted special attention in the case of the Tsetse owing to their blood-thirsty nature and the fatal consequences of their bites when inflicted upon domestic animals. Although not "social" insects in the ordinary sense of the term as applied to animal communities, Diptera, as a whole, show a marked *social tendency* on the part of individuals of the same species. That is to say, there is a tendency which causes individuals of the same species to assemble in particular places in more or less close proximity to one another, although without exhibiting anything in the shape of mutual aid. Thus, in spite of the fact that the distribution of most species of Diptera is remarkably wide, it will be found in the majority of cases that individuals of the same species do not occur everywhere throughout its area, but are confined to particular spots; and wherever they are met with they are usually to be found in some numbers. Of course there are many exceptions, but the generalisation nevertheless holds good. Again, although remarkable instances of migration have been recorded in the case of certain species of Diptera, they must be regarded as exceptional, and it will be found that Diptera, as a rule, do not travel far from the spot in which their larval existence was passed. The result is that we find a larger or smaller number of individuals of the same species collected within, perhaps, quite a small area, outside which it may be impossible to find a single example. This is well-known in the case of the midges and other allied forms, which attract attention owing to the habit of the males of collecting together and dancing in the air in a swarm at certain seasons; and similar phenomena are exhibited by the males of certain species of Muscidæ (belonging to what is still generally termed the Family Anthomyidæ). In England, again, phenomena precisely analogous to "Fly-belts" are displayed on a limited scale by some of the smaller forms of "daddy-long-legs"

belonging to the Family Limnobidæ, species of which have been found to be confined to certain damp spots in woods, where individuals are always to be met with in smaller or larger numbers at the proper season, although none may be found in what are apparently equally suitable localities elsewhere. Thus the occurrence of Tsetse-flies in "belts" is not difficult of explanation, although the alleged fact that animals may be in perfect safety on one bank of a stream when bushes on the other side are full of the fly is exceedingly hard to understand.

Association of Tsetse with Big Game.

Although, as already explained in a previous section, the Tsetse is particularly local in its distribution, and is only found in warm, moist tracts in the neighbourhood of water, where cover occurs in the shape of forest or bush, the only possible conclusion to be drawn from the practically unanimous and very numerous statements on the subject of the connection between the fly and game, which will be found in the Bibliography, is that were it not for the big game, on the blood of which it feeds, the Tsetse would soon cease to exist, at least in numbers sufficient to be formidable. Mr. Alfred Sharpe, C.B., writing to Lord Lansdowne from Zomba, British Central Africa Protectorate on September 30th, 1901, says: "Tsetse-fly would appear to depend upon wild game for their existence, as I have never found Tsetse in any locality where game was totally non-existent" (Chapter VII. Appendix C, p. 295). So far as I am aware the only evidence to the contrary comes from East Africa, where, according to the testimony of various observers, Tsetse would appear to be less intimately connected with game than in the Central and Southern portion of the Continent [127, 151]. Thus Mr. J. W. P. McClellan, writing from Nairobi, East Africa Protectorate, on September 4th, 1901, expresses the opinion that "Tsetse-fly is to be found in certain dark, damp, low-lying localities, irrespective of big game of any kind" (Chapter VII., Appendix C, p. 294). Again, Mr. F. J. Jackson [127] states that "it is supposed by a good many people that the Tsétsé-fly only exists where game beasts, especially buffaloes, are most plentiful, and that the fly disappears as the game is killed off or driven away. This may be so in South Africa, but it is certainly not the case in East Africa, as the belts of fly country in East Africa are almost devoid of game, with the exception of the river Tana." Mr. Neumann [151], writing of the Athi River above its junction with the Tsavo, in May 1895, notes the remarkable

scarcity of game "even along the banks of the river." He adds: "Here are great stretches of uninhabited bush country with a perennial river running through it, and hardly any animals, though plenty of birds and of 'fly' (Tsetse)." More recently, in a letter to the Marquis of Lansdowne, dated 27th September, 1901 (see Chapter VII., Appendix C, p. 297), Mr. Jackson has expressed the belief that "the Tsetse is, like the mosquito, only a blood-sucker by predilection." The meaning of this phrase would appear to be that, in default of blood, which it prefers, the Tsetse can continue to subsist on the juices of plants. Be this as it may, it must, I think, be regarded as an established fact that when game absolutely ceases to exist in a given locality, the Tsetse-fly, if present, soon disappears. As an argument in support of his belief, Mr. Jackson mentions that near Kibwezi, in East Africa, in April 1892, "at a time when the whole of the 'fly-belt' was parched and dried up—there being no water between Msogoleni and Tsavo River, a distance of fifty miles, and consequently no game of any kind—the Tsetse was more plentiful than at any other time, before or since," when he has traversed that district. He also states that though a species of Tsetse is "plentiful" in the Botanical Gardens at Entebbe, on Lake Victoria, there are no mammals there "with the exception of a few monkeys and squirrels, and certain small nocturnal beasts, such as ichneumons, etc., and an occasional hippopotamus." Whether the proboscis of the Tsetse can pierce the integument of plants as easily as that of mammals has yet to be proved by actual observation; at any rate no one has so far ventured to make such an assertion. But in connection with Mr. Jackson's statements it must be remarked that even assuming that the Tsetse in the Botanical Gardens at Entebbe make up for the deficiency in the supply of mammalian blood by imbibing the juices of flowers and plants, those in the fly-belt near Kibwezi could hardly have done so, since we are expressly told that at the time referred to the whole area was "parched and dried up."

The true explanation of the Kibwezi phenomenon seems to be that it is possible for one generation of adult Tsetse-flies, as for other adult insects, to continue to live for some time or for the whole period of existence without food, if the latter is not forthcoming. Thus assuming a fly-belt to be deprived of all mammalian life, the Tsetse-flies which thereafter emerged from pupæ would continue to exist even though fasting; and they

would naturally avail themselves of the opportunity of obtaining a meal of blood afforded by the passage of men and other animals through their haunts. Whether reproduction is impossible without such a meal, as appears to be the case as regards certain species of mosquitoes although apparently not the rule, remains to be proved. If, however, Tsetse which have not fed on blood are incapable of reproduction, it follows that they would become extinct in one generation after this food supply ceased.

Our knowledge of the distribution of the various species of *Glossina* is as yet very scanty, but it is possible that the species concerned in Mr. Jackson's statement with regard to the Fly-belts in East Africa [127] referred to above, is *Gl. pallidipes*, Austen, rather than *Gl. morsitans*, Westw. If this is so, the discrepancy between Mr. Jackson's testimony and the consensus of opinion as to the close association between *Gl. morsitans* and big game might be due to a difference in the habits of the two species. But the more probable explanation would seem to be that, as already mentioned in a previous section, the Tsetse will not live on open grassy plains, even when teeming with game.* It may be added that in the subsequent letter to Lord Lansdowne, Mr. Jackson appears at the outset to admit the connection, even in East Africa, between the Tsetse and game; although, as already shown, he afterwards advances the view that "the Tsetse is . . . . only a blood-sucker by predilection."

Three species of Tsetse† are known to occur in East Africa, and more precise observations are necessary to decide the relationship between each of them and the game of that region. With regard to South Africa, however, there can be no question that the extermination of big game has been followed or accompanied by the disappearance of the Tsetse from many localities in which it formerly abounded. That this would ultimately be the case was suggested long ago by Livingstone [21], and the assertion has been repeated by many subsequent writers.‡ Ample proof of the correctness of the forecast is furnished by what has taken place in the more southern portions of the Transvaal [105, 112]. In South Africa, according to the testimony of various

* In East Africa, according to Mr. Jackson [127], "the open, undulating, grassy plains of the Masai country, and other places of a like nature, are the headquarters of by far the greatest quantity and variety of game, and are entirely free from the Tsétsé-fly, ..."

† *Glossina morsitans*, Westw., *Gl. pallidipes*, Austen, and *Gl. fusca*, Walker.

‡ *Cf.* 55, 57, 112, 128, 135, 153.

writers, the Tsetse follows the movements of the big game, and should the latter return to a locality from which it has been driven out the fly may come back with it. This is stated to have happened in the country between the Gwaai and Deka rivers in Rhodesia, in consequence of Matabele and other raids [77, 153]; and similarly in Zululand the Tsetse is said to have increased in numbers, as an indirect result of the Zulu War of 1879, since the devastation of many inhabited tracts caused by the campaign led to the multiplication of wild animals in these localities.

Whether the Tsetse is more partial to and more dependent upon one species of game than another is doubtful, although the majority of writers, from Chapman [30] onwards, have stated that it is especially associated with the buffalo. Most of these statements naturally refer to South Africa, and a possible explanation is that in that region, prior to the advent of the rinderpest, the buffalo was more abundant than other game in precisely those localities beloved by the Tsetse [*cf.* Selous, 76]. In Central and East Africa, at any rate, as shown by the letters from well-qualified observers printed in Chapter VII., Appendix C, and elicited by the assertion that to protect the buffalo would be tantamount to protecting the Tsetse as well, the latter does not appear to be more dependent upon the buffalo than upon any other species of game. The association of the Tsetse with the buffalo in South Africa has led to the belief that the fly breeds in the dung of that animal, but thanks to the observations of Colonel Bruce we now know that this idea is without foundation. In addition to the buffalo, various writers have stated that they have found the Tsetse associated with the elephant, rhinoceros, and the larger antelopes, while Livingstone [49], who met with the Tsetse on the Rovuma River in 1866, found that the only game in that locality were hippopotamus and pig.

Seasonal Prevalence.

Although it has been stated by Colonel Bruce that, so far as he is aware, "Nagana is not confined to certain months of the year as Surra is,"* the Tsetse itself, where it occurs, would appear to be more abundant at one season of the year than at another, while temporarily it may even be absent altogether. Thus, according to Buxton [41]: "The fly appears only at certain seasons, . . . The head of a kraal, about thirty miles distant from the point where we found the Tsetse most abundant, told us at that time the fly

* *Cf.* Chapter VII., Appendix A, p. 286.

was not in his district, and pointed to a heifer and some goats, which he said he intended to send away before the fly season came on." Our information on this point, however, is as yet very scanty, and to a certain extent conflicting. It was found by Harris [5] that the fly infested the Mural Berge, in the north of the Transvaal, especially during the rainy season; and Mr. and Mrs. Petherick [37] were informed that at the same period of the year a certain kraal in the country of the Rhol tribe, to the north-west of Gondokoro, was untenable owing to the presence of Tsetse. According to Chapman [30], the Tsetse "often moves about" with the buffalo in the rainy season; but the same writer subsequently states that "heavy rains are said to kill the fly in the season when they prevail." Kirk [28] tells us that Tsetse are "most numerous and troublesome in the hot sultry weather before rains;" while Mr. F. J. Jackson [119], speaking of East Africa, says that, "where it exists," the fly "appears in much greater numbers on a dull or rainy day." It should be noted that in South Africa, at any rate, the rains fall in the summer, the winter being the dry season. It is therefore curious, especially in view of the evidence already adduced, to find that Dr. Bradshaw [77], writing of the fly-belt on the south bank of the Zambesi and Chobe, states that the Tsetse "is much more plentiful during the winter months, namely, from April to end of September, than during the summer"; while, on the other hand, Selous, referring to the Batonga country between the Zongwe River and the Zambesi in June (mid-winter), says that Tsetse were "pretty numerous, and must be very much so later on during the hot months." Bradshaw, however, is supported by an experience of Dr. Holub, who on the Mo-Njeko River, on August 7th, 1886, found Tsetse more abundant than he had ever seen them before.

The first of Colonel Bruce's suggestions for future work on Tsetse-fly disease* is—"That all trustworthy information regarding seasonal prevalence [of Nagana] be collected": it will have been seen from the foregoing statements that "trustworthy information" as to the seasonal prevalence of Tsetse-flies themselves is equally necessary.

Period of the day at which Tsetse-flies are most active.

The Tsetse, like other day-flying insects, does not begin to be active until the sun grows hot. Livingstone [21] states that it is "remarkably alert, avoiding most dexterously all attempts to capture

* *Cf.* Chapter VII., Appendix A, p. 286.

it with the hand at common temperatures;* in the cool of the mornings and evenings it is less agile." Again, according to Colonel Bruce,†—"The Tsetse is not at all easy to catch with the hand, especially during the day, being nimble and quick of movement, but at early morning or sunset they become more lethargic, and are then more readily secured." The following remarks by Sir John Kirk [28] are also worth quoting:—"In the morning, while the dew hangs on the grass, and before the heat of the rising sun has warmed the air, the Tsetse is dull and sluggish, resting on the under side of some leaf or blade of grass; when forced to take wing they may then be easily caught. Even at nine o'clock they are not very active, and fly about with a peculiar buzzing sound; with the heat of the day they become a real annoyance to the traveller, constantly biting him on the hands, face, or neck, dexterously evading a blow, and again alighting on the very spot from which they have been driven."

According to Captain Crawshay,‡ the Tsetse bites "at any time," but is "most aggressive" "during the hottest hours of the day"; Bradshaw [77] says, "It bites throughout the day, except when it rains"; and Selous [76], writing of the plague of Tsetse-flies on the south bank of the Zambesi and Chobe, to the west of the Victoria Falls, in 1874, speaks of the insects as "attacking one in a perfect swarm, from daylight till sunset." On the other hand, Colonel Bruce, describing his experience of Tsetse-flies in Zululand, says: "About sunset seems a favourite feeding-time, and then the poor creatures [horses] would be surrounded by a perfect cloud of the flies, while some hundreds of them would be settled on them at the same moment."§ Again, it may be noted that Dr. W. S. Radford, referring to a species of "gad-fly" (*i.e.*, *horse-fly*) in Jubaland, East Africa Protectorate, the bites of which he asserts produce in camels symptoms "identical in every particular with those produced by Tsetse," states that "This fly, unlike the Tsetse, attacks animals during the day at all hours."‖ The inference from this, although Dr. Radford does not mention the period of the day at which Tsetse-flies in Jubaland are most aggressive, is opposed to the testimony of Crawshay, Bradshaw, and Selous, which has already been quoted. But the explanation may very possibly be that the Jubaland Tsetse-fly

* Baines [55] states that on a cold day the fly is "dormant."—E. E. A.
† *Cf.* Chapter VII., Appendix A, p. 272.
‡ Chapter VII., Appendix B, p. 288.
§ *Cf.* Chapter VII., Appendix A, p. 272.
‖ Chapter VII., Appendix C, p. 293.

belongs to a species * with habits somewhat different from those of *Glossina morsitans* and the other better-known forms.

Behaviour at night.

The Tsetse appears to pass the night resting either on the ground or on the smaller branches of bushes and trees,† and although there is a wide-spread belief that during the hours of darkness fly-belts may be crossed with impunity, there is abundant evidence to show that this is not invariably the case. A moonlight night during the South African winter may be safe enough,‡ but at other seasons and in more tropical latitudes it is well to wait until the temperature of the air has fallen sufficiently to render the insects sluggish. Bradshaw [77] states that the Tsetse bites "during part of the night, if warm," adding, "I consider it dangerous to travel at night with cattle and horses, until it begins to grow cold towards the middle of the night, as I have been bitten often until past 11 P.M." Selous [76] describes a moonlight tramp along the Chobe River, when the Tsetse "kept flying up from the ground on to my naked legs, and bit as furiously as in the daytime"; and Captain Crawshay, writing of his experience of Tsetse-flies in Nyasaland, agrees that they bite at night as well as by day, when the moon is bright.§ On the other hand, Kirk [28] writes: "By night I have never been bitten by Tsetse, nor do they fly about after sunset"; and Bruce‖ says that he has "not noticed them biting during the night...." These discrepancies, however, are no doubt due to differences in locality, temperature, and other conditions. Captain A. St. H. Gibbons [152], writing of his experience of Tsetse on the Njoko River, Northern Rhodesia, in August 1895, says: "At night the danger is very small, though it is a mistake to imagine that the Tsetse keeps such early hours as other flies. I have at times been worried by them an hour after the sun has gone down, and have known flies to buzz into my tent as late as 9 o'clock on a dark night

* Perhaps *Glossina longipennis*, Corti.

† Dr. Holub [110] draws attention to the risk incurred by crossing at night "certain thickly-wooded laterite knolls," in the vicinity of the Zambesi, which happen to be infested by Tsetse, since owing to the narrowness of the track it is impossible to prevent the waggons from brushing the flies from the twigs and carrying them along.

‡ *Cf.* C. J. Andersson, [20].

§ *Cf.* Chapter VII., Appendix B, p. 288. Sir Harry Johnston's advice [145] that, "if a Tsetse-haunted district must be crossed, it should be done at night-time—by moonlight if possible," should therefore be received with caution. According to Baines [55], a "dark and cloudy" night is safest.

‖ *Cf.* Chapter VII., Appendix A, p. 272.

and make a bold dash for supper at my expense. At that time of night they are easily caught, and almost invariably found their way into spirits of wine."

Mode of flight, and noise produced by Tsetse when on the wing.

Authorities agree in describing the flight of the Tsetse as "rapid and straight" [30, 55]. Baines [55] says that "its sight and smell seem to be keen," and Foà [135] asserts that it "comes to its prey from a long distance, whether it is that its sight is keen or its sense of smell is exceptionally acute." * In the opinion of M. Foà the latter suggestion is more probably correct, since he has observed that the Tsetse "always comes up wind, and generally bites by preference on the leeward side." Colonel Bruce writes †:—"The Tsetse has a direct flight, flopping, if I may use the term, suddenly on the animal attacked, and is very pertinacious." On the completion of its meal, "when its abdomen is full of blood, its flight becomes heavy and it at once hides itself in order to digest its meal in peace" [135].

That the Tsetse owes its name to the sound produced by it when on the wing has already been pointed out in the note at the commencement of this chapter,‡ and its characteristic buzz has been referred to by various writers. Bradshaw [77] remarks that, "Its buzz is peculiar and not easily forgotten"; while according to Livingstone [21], "Its peculiar buzz, when once heard, can never be forgotten." Captain Gibbons writes [152]:—"The fly is frequently to be heard giving vent to the high pitched buzzing note which gives it a name . . . ": and Colonel Bruce says,§ "The fly makes a loud buzzing sound when flying, but after its feed and at rest it emits a peculiar sharp, shrill note, probably caused by an action of the wings." ‖ According to

* It may be remarked that a large sense-organ, possibly olfactory in function, is situated in the third joint of the Tsetse's antenna (See Fig. 9, p. 63).

† *Vide* Chapter VII., Appendix A, p. 272.

‡ See page 1.

§ *Vide* Chapter VII., Appendix A, p. 272.

‖ The postprandial song of the Tsetse is more probably produced by the thoracic stigmata or spiracles, or by the vibration of the thoracic walls. A large number of Diptera, especially Muscidæ and Syrphidæ (Hover-flies, &c.), possess the power of thus producing a shrill sound while at rest, with the wings closed. *Cf.* "*Sericomyia borealis singing while at rest*": Rev. E. N. Bloomfield, *Entomologist's Monthly Magazine*, Vol. XVIII. (1881), pp. 159–160: see also, A. H. Swinton, *ibid.* (January 1882), pp. 189–190, and J. Hellins, *ibid.*, p. 190. G. C. Bignell (*Entomologist's Monthly Magazine*, 2nd Series, Vol. II. (1891), p. 225) states that *Microdon mutabilis* (Linn.), a somewhat rare British Syrphid, produces a humming noise when at rest and annoyed, by means of the vibration of the halteres (the little knobbed organs found in all Diptera, except certain

Captain Crawshay,* the flight of the Tsetse "is powerful and noisy: the buzz is full-toned and somewhat highly-pitched—not dull and droning like the buzz of the ordinary horse-fly."

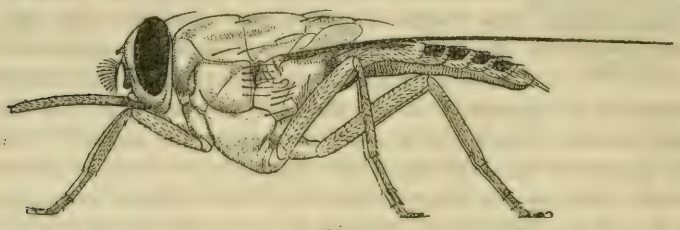

Fig. 5.

A Tsetse-fly (*Glossina morsitans*, Westw., ♀), before feeding. (× 6.)

Behaviour when sucking blood: time taken by the fly in sucking its fill: blood-sucking habit common to both sexes.

When alighting for the purpose of making a meal, Tsetse-flies, according to Captain Crawshay,* "do not settle as slowly as the horse-fly but land with a bump, standing well up on their legs." The method of feeding is described by the same authority as follows:* "When a 'Tse-Tse' settles with the intention of feeding—in the early mornings they usually simply settle on men's backs to sun themselves, away from the ground and vegetation wet with the

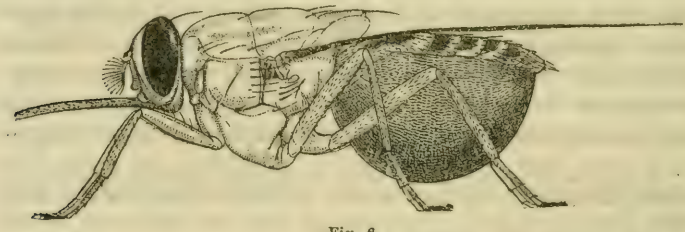

Fig. 6.

A Tsetse-fly (*Glossina morsitans*, Westw., ♀), after feeding, showing abdomen distended with blood. (× 6.) From a drawing from life, kindly lent by Lt.-Colonel Bruce.

dew—he inserts his proboscis, lowers his head, and raises his abdomen until it is almost vertical: when doing this, and for some little time after he has commenced sucking, he works his

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wingless forms, and projecting from the thorax behind the wings), which come into contact with "some short bristly hairs situated on the abdomen and pointing towards the thorax."

* Chapter VII., Appendix B, p. 288.

wings, buzzing in a minor key, rather like a bee when held forcibly, though not so powerfully: when the keenness of his appetite has been somewhat appeased, he stops working his wings and sucks in silence. If left to himself, he will suck until his originally skinny barred abdomen becomes a large crimson bead [compare Figs. 5 and 6]. He is then almost helpless: if touched he will not fly, and if brushed off he will only go a yard or two, to settle heavily on a bush, or gradually sink down to the ground." A similar account is given by Foà [135], who writes:—"When it settles, it does so so gently that one does not feel it; it remains thus motionless for fifteen or twenty seconds, its proboscis projecting in front, in a mistrustful attitude, ready to take flight. When it believes itself safe, it lowers its weapon, separates its feet so as to flatten itself out more and pierces the flesh without causing any pain to start with, as does the mosquito. . . . While its proboscis, which is at least a quarter of a centimetre in length, disappears completely in the flesh, it remains motionless sucking blood, its abdomen swelling and becoming rose-coloured owing to its transparency, and immediately afterwards appearing deep red and plump. It is not until the moment when it has already imbibed a large portion of its meal, that a slight pain or rather itching betokens its presence. When its stomach is full it is still very difficult to catch with the hand, for it does not fly off, but quickly dodges to one side."

It should be noted that M. Foà's statement that the proboscis of the Tsetse "pierces the flesh without causing any pain to start with," is not altogether borne out by the experience of others. Thus, according to Selous [76], the bite of the Tsetse is "far more severe" than that of a flea, and "about one in every ten bites (that perhaps touches a nerve) closely resembles the sting of a wasp or bee, as it will cause one when seated to spring up as if pricked with a needle;" while Colonel Bruce writes*:—"In man the burying of the proboscis in the skin is accompanied by a sharp prick, which draws one's attention suddenly to the spot; but the pain is, as a rule, trivial, and the subsequent redness and irritation very slight indeed—in fact, less than that caused by the mosquito." Captain Gibbons [152] states that the tread of the Tsetse "is so light that the sharp prick of the proboscis is generally the first indication of his whereabouts."† According to Mr. F. J. Jackson [119]:—"Its bite in man, though very

* *Cf.* Chapter VII., Appendix A, p. 272. † See also [27].

sharp and needle-like, leaves no irritation, and it invariably chooses those parts that are shaded from the rays of the sun—such as under the brim of the hat, behind the ear, neck, and under the throat if not protected by a beard. If allowed to suck itself full, its body becomes so distended that it has the appearance of a small unripe purple grape [see Fig. 6], and it is unable to fly more than a few yards before settling. Its proboscis, which is very slightly curved downwards, is attached to the head horizontally, and is protected by a sheath divided longitudinally. When it bites the proboscis is vertically lowered, whilst the double sheath is retained in its horizonal position." The "sheath" here referred to is formed by the palpi, which in the normal position, when the proboscis is not in use, are applied to the latter so closely as to conceal it and give the appearance of a single organ.

According to Chapman [30] the Tsetse "assails different animals in their most defenceless parts: a man behind the back between the shoulders, and an ox on the back or under the belly; a horse in the same places, and inside the nostrils; and a dog on the forehead, &c." Colonel Bruce writes: *—"It affects in horses the legs, especially in the region of the fetlock, and on being detached from its position by the vigorous kick the horse gives, will only rise a few inches and again settle near the same spot. After the initial prick there is no irritation, and the animal will stand quietly while the fly has its feed." Stanley, however [45], describes an occasion when, owing to the bites of Tsetse, "Horses and donkeys streamed with blood, and reared and kicked through the pain": and Rankin [79], in his account of the experiment made to test the value of elephants as baggage-animals in East Africa, states that, "The fly swarmed on the elephants till blood trickled down their flanks in a constant stream." The writer adds that although the elephants "endured this" for days, without subsequently showing any "prolonged signs" of Tsetse-fly disease, they "seemed pained and distressed during the infliction" of the bites.

The time taken by the Tsetse in sucking its fill is remarkably short. According to Andersson [20] it is but "a few seconds"; while Colonel Bruce says†: "It is astonishing with what rapidity the flies fill themselves; in as small a space of time as twenty or thirty seconds a fly will become swollen out like a balloon with bright red blood" [see Fig. 6].

Contrary to what is the case among horse-flies (Tabanidæ), of

* *Cf.* Chapter VII., Appendix A, p. 272. † *Ibid*, p. 271.

which the females alone suck blood, in the Tsetse both sexes are blood-sucking flies. This has at present been recorded only by Colonel Bruce,* whose statement, however, is supported by the fact that a male of *Glossina longipennis*, Corti, from Somaliland, in the collection of the British Museum, has its abdomen swollen and distorted, owing to containing decomposed blood, while a small globule of dried blood may be seen adhering to the end of its proboscis.

Dislike of Tsetse to human habitations, and to animal excreta.

It is remarkable that ordure, which has so strong an attraction for many Diptera (especially of the family Muscidæ, to which the genus *Glossina* belongs), has precisely the opposite effect on the Tsetse. For this reason the fly appears to avoid the presence of man, and is rarely found in the vicinity of human habitations, or within the confines of a town or other settlement.† Livingstone [21] alludes to "the well-known disgust which the Tsetse shows to animal excreta, as exhibited when a village is placed in its habitat," and states that the fact "has been observed and turned to account by some of the [native] doctors," who protect animals about to pass through a fly-belt by smearing them over with a mixture containing excrement and other ingredients. Similar statements have also been made by subsequent writers [*cf.* Kirk, 28, and Captain Gibbons, 152]. According to Foà [135], on killing an antelope in a patch of "Fly," "in order to get rid of the Tsetse, which literally cover game and hunters, it is only necessary to open the animal's belly and evacuate the entrails; the insect at once ceases to torment you."

Reproduction.

Until the publication of Colonel Bruce's "Report," the Tsetse was believed to lay eggs and breed in the droppings of the buffalo, and various writers have attempted to account in this way for the close association that, in South Africa, at any rate, was alleged to exist between the fly and that animal [*cf.* Bradshaw, 77, and Nicholls and Eglington, 114]. But although the flies belonging to the genera *Stomoxys* and *Lyperosia*, which are the nearest existing allies of *Glossina*, undoubtedly breed in dung,‡ it will not surprise the

* *Cf.* Chapter VII., Appendix A, p. 273.

† That this is not invariably the case is shown by the fact that the British Museum collection contains specimens of *Glossina pallidipes*, Austen, stated to have been "caught in Witu town."

‡ Bouché ("*Naturgeschichte der Insekten*" (Berlin, 1834) pp. 55–56) states that the larva of the common European *Stomoxys calcitrans*, Linn., is found in summer and autumn in horse-dung, in company with the larva

reader, after what has been stated in the preceding paragraph, to learn that the Tsetse has a totally different life-history, albeit the details of the process are even more exceptional than could have been anticipated.

According to Colonel Bruce: * "The Tsetse-fly does not lay eggs as do the majority of the Diptera, but extrudes a yellow-coloured larva nearly as large as the abdomen of the mother. This larva is furnished with a black hood at one pole and two minute spikes at the other. It is annulated and consists of ten segments. Immediately on being born the larva creeps about with a good deal of activity, evidently searching for some cover or hole in which to hide. Having found a resting-place, it immediately begins to change colour, and after a few hours has turned into a jet-black hard pupa or nympha.

"If these pupal cases are placed in a perfectly dry place, as in a wooden box, the perfect insect hatches out in about six weeks. From this it would appear that the life-history of this species of fly is very simple, it only being necessary for the female insect to deposit the larva on the surface of the soil or in the grass, when the larva creeps into the nearest shelter, in a few hours becomes hard and black, and in five or six weeks hatches out into the fully-developed Tsetse-fly. It has often been surmised that this fly is bred in buffalo-dung, but from a consideration of the foregoing facts it is evident that nothing is wanted except any moderately dry place."

Such are the details of the life-history of the Tsetse as presented by Colonel Bruce, and it will at once be perceived by those who know anything of the metamorphosis of Diptera in general that they exhibit a remarkable similarity to what takes place in the group of parasitic flies which, on account of their peculiar mode of reproduction, have been termed Pupipara.†

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of the house-fly (*Musca domestica*, Linn.), which it much resembles. *Lyperosia irritans*, Linn., is said to breed in cow-dung. (*Cf.* "Insect Life," Vol. II. (1889), p. 97): in the paper referred to, the species is called *Hæmatobia serrata*, Rob.-Desv.).

* *Cf.* Chapter VII., Appendix A, p. 271.

† Of these the best known are the mammal- and bird-parasites belonging to the family Hippoboscidæ (genera *Hippobosca*, *Ornithomyia*, *Stenopteryx*, *Oxypterum*, *Lipoptena*, and *Melophagus*). *Hippobosca equina*, Linn., is a well-known plague of horses and cattle in the New Forest; other species occur in Africa and India, and are found on horses, cattle, camels, and dogs; the genus *Ornithomyia* includes a number of species, all of which are parasitic on various kinds of birds; *Stenopteryx hirundinis*, Linn., is found on the martin (*Chelidon urbica*, Linn.), *Oxypterum pallidum*, Leach, on the swift (*Cypselus apus*, Linn.); *Lipoptena cervi*, Linn., is parasitic on the red- and roe-deer, while *Melophagus ovinus*, Linn., is the

Further observations, however, on the reproduction of Tsetse-flies are urgently needed, particularly with a view to discovering whether the process is the same in all the species. From the reproductions of photographs given by Colonel Bruce in his "Further Report," one of which represents a fly in the act of parturition, the species which formed the subject of his investigations would appear to have been *Glossina pallidipes*, Austen, rather than *Gl. morsitans*, Westw. It is therefore necessary to point out that, from what we know of the life-history of other Muscidæ, it must not be taken for granted that all species of *Glossina* necessarily produce a full-grown larva, which immediately assumes the pupal stage, since in some genera there is a remarkable diversity in the mode of reproduction even in the case of closely allied species. Thus, according to Portchinski, the common European *Mesembrina meridiana*, Linn., is viviparous, while *Mesembrina resplendens*, Wahlbg., and *M. mystacea*, Linn., lay eggs; and whereas *Musca domestica*, Linn., lays from 120 to 160 small eggs, *Musca corvina*, Fabr., either lays about twenty-four large eggs, provided with peculiar appendages, or, as was found by Portchinski to be the case in summer in the Crimea, produces a single full-grown larva.*

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so-called "sheep-tick." In all of these the female produces but a single full-grown larva at a birth. While within the body of the mother the larva is nourished by the secretion of special glands, and assumes the pupal stage immediately after extrusion: unlike that of the Zululand Tsetse, the Hippoboscid larva is incapable of movement. Bruce's description shows that the larva of the Zululand Tsetse-fly must be very similar in appearance to the newly-extruded larva of *Hippobosca equina*, which is yellowish white in colour, with the terminal segment deep black. The latter also exhibits two prominences, which, however, although distinct, are not so pronounced as in the larva of the Zululand Tsetse. The mature pupa of *Hippobosca* is dark brown, but shows no distinct trace of segmentation. In *Hippobosca camelina*, Savigny, which is parasitic on camels in Northern Africa and in Asia, and is a much larger species than *H. equina*, the protuberances at the posterior end of the pupa are scarcely distinguishable, although the dull black area is just discernible. In *Oxypterum pallidum* the pupa shows faint traces of the annuli belonging to the larval integument, while the "black hood" takes the shape of a flat rosette-shaped plate, devoid of prominences.

* *Cf.* Baron C. R. Osten Sacken, "On Mr. Portchinski's publications on the larvæ of Muscidæ": *Berliner Entomologische Zeitschrift*, Bd. xxxi. (1887), pp. 17–28). According to Portchinski, *Musca corvina* in Northern Europe deposits on dung about twenty-four large eggs with peculiar appendages. In the Crimea in early spring its reproduction takes place in the same way; but towards the end of spring, and in summer almost exclusively, Portchinski found a single very large egg within a matrix-like expansion in the body of the female. From this egg a larva was developed which grew within the body of the mother, but passed directly from the first to the third, or final stage (*Cf.* Osten Sacken, *loc. cit.*, p. 26). Another remarkable instance of larval development within the body of the

From the examination of a series of Tsetse-fly pupæ from Zululand, kindly presented to the British Museum by Colonel Bruce, I am enabled to give the following description of the pupal stage (Fig. 7) in the only species of which the life-history has yet been observed. As will be seen from remarks in Chapter IV.,* the identity of the species is a little uncertain, though it must be either *Glossina morsitans*, Westw., or *Gl. pallidipes*, Austen.

The extreme length of the pupa in this species varies from $6\frac{1}{3}$ to 7 millimetres (3 to $3\frac{1}{4}$ lines), while its greatest width is from $3\frac{1}{3}$ to $3\frac{2}{3}$ millimetres ($1\frac{3}{5}$ to $1\frac{3}{4}$ lines). The colour is dark brown, except in the case of the last segment which is deep black, representing what Bruce calls the "black hood" in the larva. In shape the pupa is very remarkable, owing to the peculiar development of the last segment. Instead of exhibiting the regular contour seen in the Muscid pupa of the ordinary "barrel-shaped" type (as in the house-fly, blow-fly, and green-bottle flies), and although the main portion of the pupa is an elliptical oval with the anterior end somewhat obtuse, similar to the pupæ of the types referred to, the posterior extremity (last segment) is

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mother was discovered by Portchinski in the case of *Dasyphora pratorum*, Mg., which also belongs to the Muscinæ, *i.e.*, to the Muscidæ in the most restricted sense. The species in question deposits in the dung of cattle a large larva, which is retained within a matrix-like receptacle in the body of the mother until it reaches the third stage. After extrusion the larva "very soon reaches its full growth and goes underground for its further development" (*Cf.* Osten Sacken, *loc. cit.*, p. 25). As to the connection between the mode of development of the Pupipara and that of the flies just mentioned, Osten Sacken writes as follows (*loc. cit.*, pp. 26–27):—"Hitherto the Pupipara had an isolated position among the Diptera. The modes of larval evolution of *Musca corvina* and *Dasyphora pratorum*, discovered by Mr. Portchinski, bridge over the interval. He even ventures the hypothesis that the Pupipara began by being coprophagous in their larval state, and laid an almost full-grown larva like that of the two above-mentioned flies. Later, owing to the parasitic mode of life of the imago and the diminution of the powers of flight necessary for providing the proper environments for the larvæ, those changes in the mode of evolution of the larvæ were produced which distinguish the Pupipara now." It is not yet known whether in the Tsetse and the other Muscidæ, which produce a single more or less adult larva at a birth, the oviduct of the female is provided with glands by the secretion of which the larva is nourished, as in the case of the so-called Pupipara; but it must be remarked that, whatever be the case with regard to the latter, Portchinski's hypothesis will not serve to explain the origin of the mode of development of the Tsetse, as exhibited by the Zululand species, which presents an even closer approximation to that of the Pupipara, than does the development of either *Musca corvina* or *Dasyphora pratorum*. For the Tsetse, although feeding on blood, is not parasitic in the ordinary sense of the term, while its powers of flight have been in no way affected by its mode of life.

* See page 89.

produced on each side into a prominent tumid lip. These lips enclose a deep pit, within which in the larval state were situated the posterior stigmata or respiratory apertures (Fig. 7a).

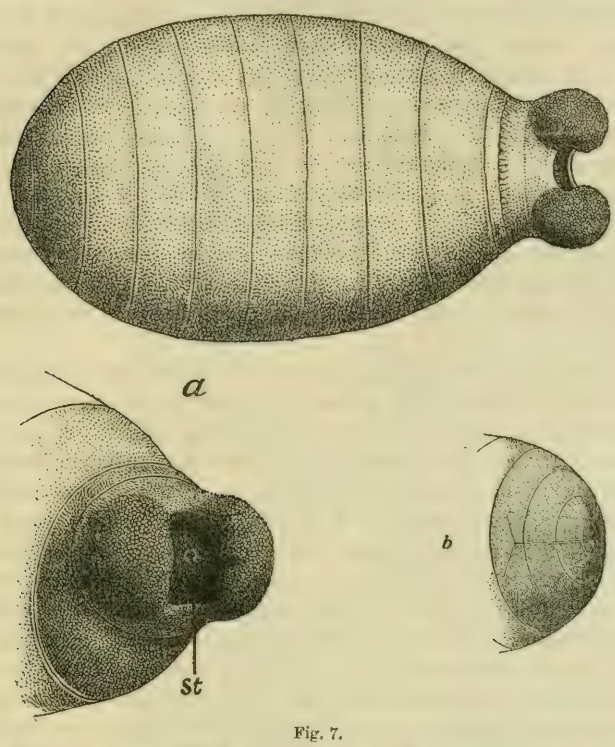

Fig. 7.

Pupa of Zululand Tsetse-fly, dorsal aspect (× 12); *a*, posterior extremity, showing pit and right larval stigma, *st* (× 24); *b*, anterior extremity, showing bifurcated longitudinal seam, which opens to permit the escape of the imago (× 8).

The pupa consists of twelve segments, divided by fine grooved rings as if traced with the point of a needle. The first eleven segments are smooth, but when examined under a low power are seen to have a shagreen-like or tessellated surface. At the anterior pole the seam which opens to permit the escape of the fly is visible as a semicircular groove, running across the first three segments in a lateral longitudinal direction, and terminating on each side in a bifurcation on the fourth segment (Fig. 7b). In the centre of the first segment (which is much smaller than any of the others), at the anterior pole, a

slight depression is noticeable, representing the mouth of the larva. When the pupa is viewed from above or below (see Fig. 7) the lateral tumid lips, into which, as already stated, the last or twelfth segment is produced, are very conspicuous. They are connected by a dorsal and a ventral ridge, and lips and ridges together enclose the above-mentioned pit, the depth of which is from $1\frac{1}{2}$ to 2 millimetres. In this pit can be seen the vestiges of the posterior stigmata of the larva, one on each side at the base of the lateral lip. Under a platyscopic lens, magnifying about ten diameters, each stigma has the appearance of a minute closed pore, surrounded by a slight elevation (see Fig. 7a). Each lip is covered externally with minute tubercles or granules, and its edge bears four more or less clearly marked grooves or furrows. The anterior margin of the last segment is slightly rugose, with small longitudinal furrows, as shown in Fig. 7.

The examination of the pupa renders it possible to supplement or amend, in one or two respects, Colonel Bruce's description of the *larva*. According to Bruce the latter consists of ten segments, but the examination of the pupa shows that in reality it is composed of twelve. In a specimen which is practically a dried larva, since pupation is evidently not complete, there are strongly marked depressions between the segments producing a conspicuously annulated appearance, which agrees with Bruce's description of the larva. Bruce states that the larva is provided with "two minute spikes" at the end opposite the "black hood"; the latter is represented in the pupa by the deep black twelfth segment, with its prominent lips. The "minute spikes" of the larva would therefore seem to be the mouth-hooks of the ordinary Muscid maggot, which in the Tsetse are perhaps used by the larva to attach itself to the wall of the oviduct of the mother. In Plate I. of Colonel Bruce's "Further Report," the pupa is likewise shown equipped with a similar pair of hooks at the anterior pole. But this must be a mistake; the pupæ before me display no trace of any such structures, and Bruce himself says nothing about them.

Geographical Distribution.

While most other genera of blood-sucking Diptera are practically world-wide in their occurrence, Tsetse-flies are confined to Africa, and a glance at the accompanying map will show the reader what has been learnt of their distribution since Sir William Cornwallis Harris [5] encountered *Glossina morsitans* to the south of the

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AFRICA

SOUTH OF THE SAHARA.

Illustrating present knowledge of the distribution of

GLOSSINA,

as compiled from records included in the Bibliography to this work, and from local data derived from specimens contained in the British Museum and other collections.

Limpopo in 1836. For reasons which have already been explained, however,* it does not necessarily follow that the Tsetse is to be found to-day in the precise localities coloured red on the map, and this applies more especially to regions south of the Zambesi. In this portion of the Continent, owing to the advance of civilisation and the retreat or disappearance of the big game, many tracts in which the fly formerly abounded are now entirely or to a large extent free from it; so that in order to learn what is known of the extent of the fly-belts in South Africa at the present time, the latter portion of the first part of the Bibliography must be consulted, in addition to the records of the localities of specimens given in Chapter IV.

With this reservation, therefore, it may be stated that so far as can be ascertained at present, either from the examination of actual specimens or from records in literature, the genus *Glossina* ranges from the Gambia in the west (approximate latitude 13° 66′ N.) to Somaliland in the east, extending south from this line until it reaches its southernmost limit in the northern portion of Zululand, near St. Lucia Lake (approximate latitude 27° 60′ S.). Quite recently it has been recorded from the region of Lake Tchad [171], but as yet we do not know whether it occurs in the Egyptian Sudan or in the river valleys and ravines of Abyssinia; although from what we are told as to the mortality among horses and mules during the Abyssinian Expedition of 1867, it is probable that it is indigenous in the latter country, at any rate [*cf.* 171]. There is, however, a doubtful record from Sennaar [47], and, should this be confirmed, the northern limit of the Tsetse would be represented by a line running from that country through Lake Tchad to the Gambia, or roughly by the 13th parallel of north latitude. But it is almost certain that the genus *Glossina* will ultimately be found to extend farther north than this, and whether it occurs or not on the White and Blue Nile up to the latitude of Khartum, it can scarcely fail to do so on the Senegal River and throughout the valley of the Niger.

It will be seen from the map that records of localities north of the Equator are at present very scanty, but that they become far more numerous in the eastern half of the southern portion of the Continent. On the western side, although the Tsetse no doubt occurs throughout Portuguese West Africa, there appear to be no records whatever of its having been met with south of the

* See pp. 10, 11.

Congo. Turning to German East Africa, we find that records are fairly numerous, but, as the map shows, they are far more abundant than anywhere else in the valleys of the Zambesi and Limpopo, which, as has been stated by many previous writers, are the main strongholds of *Glossina morsitans*. Although still or formerly occurring extensively in the northern and eastern portions of the Transvaal, the Tsetse, as already explained,* does not enter the Orange River Colony; but *Glossina morsitans*, probably in company with *Gl. pallidipes*, abounds in Zululand, at least in the northern portion of that country between the Lebombo Mountains and St. Lucia Lake.

In conclusion, it may be stated that there can be little doubt that species of *Glossina* will eventually be found to occur at intervals throughout Tropical Africa, wherever the conditions are suitable† and there is a chance of obtaining food.

* See page 7.

† See page 7. While the Tsetse recedes before the advance of civilisation, this is not the case with regard to other blood-sucking flies, some of which may ultimately prove to be capable of conveying *Trypanosoma brucei* (see Chapter VII., Appendix E, page 303). It would therefore seem to be highly desirable that investigations should be set on foot without delay with a view to determining the geographical distribution of the latter; that is, that the endeavour should be made, on the lines of Colonel Bruce's inoculation experiments, to discover in what regions of Africa the parasite of Tsetse-fly disease is naturally present in the blood of wild animals. For this purpose, as pointed out by Colonel Bruce (*cf.* Chapter VII., Appendix A, p. 286) *all* wild animals should be examined, and not merely those usually entitled "game."

CHAPTER II.

HISTORICAL SURVEY.

I.—Bionomic.

In the minds of most people Tsetse-flies appear to be especially associated with the name of David Livingstone, as though the celebrated missionary-explorer had been the first to discover and bring them to notice. This assumption, however, is not borne out by facts. As may be seen from the "Bibliography" (Chapter VI.), and as will be shown below, Livingstone's works contain numerous statements concerning the Tsetse, while at the outset of the expedition which resulted in his death among the swamps of Lake Bangweolo Livingstone made a particularly interesting experiment with a view to ascertaining whether Indian buffaloes and camels were proof against the disease disseminated by the fly. But, as will be seen later on, references to the Tsetse-fly and its habits had appeared in works published before the year 1857 (the date of the publication of "Missionary Travels"), while for the earliest notices of the havoc wrought by the fly* we must go back nearly three hundred years.

According to Sir Harry Johnston [145, 160]† we read in Portuguese records how the "earlier Portuguese expeditions of five hundred or six hundred mounted men, which would set out from Sena on the Lower Zambezi in the 16th and 17th centuries to secure the gold mines to the north and south," were brought to ruin owing to the deaths of the horses from the bite of a fly,

* In a chapter dealing with the history of our knowledge of the Tsetse-flies it is impossible to avoid constant reference to *Tsetse-fly disease*, although, since the epoch-making work of Lieut.-Col. Bruce (see Chapter VII., Appendix A), the earlier theories as to the etiology of the disease possess a purely historic interest.

† The numbers in square brackets refer to the "Bibliography" (Chapter VI.).

which there can be little doubt was the Tsetse. Sir Harry Johnston proceeds to show [145] that—"But for the Tsetse-fly, the whole history of South-Central Africa would be different."

Returning to the nineteenth century, we find as early as the year 1813, in the well-known "Travels to Discover the Source of the Nile," of James Bruce [1], statements concerning the "*Tsaltsalya* or *Fly*," of which the modern Arabic name is said to be *Zimb*. This insect, of which a rough wood-cut is given, is stated to be destructive to cattle during the rainy season on the Upper Atbara River, on the confines of the Sudan and Abyssinia. All that can be said, after an examination of the description and figure, is that the insect is either a Tsetse or a horse-fly (Family *Tabanidæ*) belonging to the genus *Pangonia*. James Bruce considered that it was the "fly" referred to in Isaiah vii, 18 and 19 [see 1], and Westwood [10], writing thirty-seven years later, was of the opinion that Bruce's "Zimb" was at any rate a species of *Glossina*, if not actually *Gl. morsitans*. If this is so, it is interesting as showing that the range of the genus extends to the Sudan on the Abyssinian frontier.

Robineau-Desvoidy [3], writing in 1830, expressed his belief that the proboscis of *Nemorhina* (*Glossina*) *palpalis* (see below, p. 71) was not used for sucking blood, an opinion that, as we shall see, was subsequently shared by his compatriot Macquart.*

So far as it has been possible to discover, the earliest English writer to refer to the Tsetse-fly in South Africa was Captain (afterwards Sir) William Cornwallis Harris [5], who, in his "Wild Sports of Southern Africa," published in 1839, states that the Mural Berge, a range of hills on the south side of the Limpopo, in the Waterberg district of the present Transvaal, are, especially during the rainy season, "infested by a large species of gad-fly, nearly the size of a honey-bee, the bite of which . . . . proves fatal to cattle." In spite of this misleading description, and although the Tsetse is not mentioned by name, there can be no doubt that it is the fly referred to.

* In a letter written in 1901, Mr. F. J. Jackson, C.B., the well-known African sportsman, gives it as his opinion that the Tsetse is, "like the mosquito, only a blood-sucker by predilection" (see Chapter VII., Appendix C, p. 297), by which he doubtless means that in default of blood it is able to exist on the juices of plants. In support of his view he mentions that in the fly-belt near Kibwezi, British East Africa, in April, 1892, when the whole district was "parched and dried up," and consequently destitute of game of any kind, he found the Tsetse more plentiful than he has ever known them before or since; but he does not say that he has ever seen a Tsetse-fly imbibing vegetable juices.

Writing in 1843 of the genus *Glossina*, of which the only species then known was *Gl. longipalpis*, Wied., the French dipterist Macquart was led [6], owing to the fineness of the mouth-parts, to infer that the flies were not blood-suckers, but subsisted upon the nectar of flowers. Macquart expressed his opinion in the following terms: "Il est probable qu'il ne vit pas du sang des animaux comme les Stomoxes, mais du suc des fleurs. Les deux soies que renferme la trompe, et qui constituent le suçoir, sont d'une finesse telle qu'il est difficile de concevoir qu'elles puissent percer la peau, et la faiblesse de cet organe paraît encore démontrée par la modification des palpes, qui s'alongent et se creusent pour lui former un fourreau" (*op. cit.* p. 113). Macquart gave some exceedingly poor figures of what he called *Glossina longipalpis* in the work in question, and in the "Supplément" [8] published in 1850.

In the latter year R. Gordon Cumming [9], who had hunted in the districts previously visited by Captain Cornwallis Harris, first mentioned by name "the fly called 'Tsetse,'" which he referred to a little later as "the famous fly called 'tsetse,' whose bite is certain death to oxen and horses." Gordon Cumming described the "hunter's scourge" as "similar to a fly in Scotland called 'kleg,' * but a little smaller," and gave the earliest published details of the effects of its bite on horses. From his use of the word *Tsetse* it is evident that it was the name given to the fly either by Boer hunters or by the natives who at that time inhabited what is now the Zoutpansberg district of the Transvaal. In the same year (1850) Westwood [10] published his well-known paper on the genus *Glossina*, in which *Glossina morsitans* and two other species (though these prove to have been previously described) were named and described (*vide infra*). Westwood quoted a letter from Major Vardon (a well-known sportsman and contemporary of Gordon Cumming), from whom he had received his specimens of *Gl. morsitans*, and endeavoured to identify the "Tsetse" of South Africa with the "Zimb" or "Tsaltsalya" of James Bruce.

Notes on the Tsetse-fly were published in 1852 and 1853 by William Cotton Oswell [11, 15, 18], who had hunted with Major Vardon, while a French writer, M. Arnaud [12], having examined a specimen of *Glossina morsitans* brought home by Oswell, expressed the opinion that it was identical with a fly met with by himself in Sennaar, where its effects on cattle appear to

* *Hæmatopota* or *Tabanus spp.* (Fam. Tabanidæ).—E. E. A.

be similar to those mentioned by James Bruce in the case of the "Zimb" on the Upper Atbara, and, during the months from January to May, the season at which it is most troublesome, cause the natives who keep cattle to behave in a similar manner to those referred to by Bruce.

In 1856 C. J. Andersson [20] gave details as to the habits of *Gl. morsitans*, with particulars of losses among domestic animals caused by it,—details which were considerably amplified in Livingstone's "Missionary Travels" [21] of the following year. Bracy Clark [22], writing in 1857, and doubtless carried away by his interest in his favourite Œstridæ (Bot- and Warble-flies), foolishly endeavoured to show that the Tsetse is identical with *Œstrus* (*Hypoderma*) *bovis*, one of the two common cattle Warble-flies of Europe. On October 5th of the same year, Westwood [24] exhibited a specimen of *Glossina morsitans*, brought home by Major Vardon, at a meeting of the Entomological Society of London, and took occasion to refute Bracy Clark's contention; but himself repeated the curious mistake first made in his paper of 1850, by stating that *Gl. morsitans* was from Lake Tchad. In the following year L. de Castelnau [23] described the habits of *Glossina morsitans*, and endeavoured to define its geographical limits; he also gave a curious account, apparently on the authority of Mr. Edwards, "the companion of Mr. Chapman," of an experiment by Bushmen to prove their assertion that the Tsetse-fly is viviparous.

Between 1860 and 1865 statements as to the occurrence and habits of the Tsetse in different parts of Africa appeared in records of travel by various writers, including Captain R. F. Burton [25], Thomas Baines [26], and David and Charles Livingstone [27]; Captain Burton, who met with the fly in the course of his expedition from Bagamoyo to Lake Tanganyika, being the first to record its occurrence in East Africa, Dr. (now Sir) John Kirk's* paper, "On the 'Tsetse' fly of Tropical Africa" [28] is the best *résumé* of our knowledge of the habits of the fly yet published. Sharing in the opinion then prevalent, that the fatal results of the bite of the Tsetse in the case of domestic animals were due to a poison, elaborated by the fly itself and injected into the wound at the moment of biting, Dr. Kirk dissected the bulb at the base of the proboscis to see whether it contained a poison gland. Those who know anything of the internal anatomy of Diptera will scarcely need to be told

* Dr. Kirk had been botanist to Livingstone's Zambesi expedition.

that he failed to find any such structure, since the salivary glands, the secretion from which produces the irritation which is experienced after a stab from a biting fly, are always situated in the *thorax*.

Sir Samuel Baker [29], writing in 1866, mentioned the Tsetse-fly as occurring in Obbo, to the south-east of Gondokoro, a new locality. James Chapman, in his "Travels in the Interior of South Africa" [30], published in 1868, gave copious details of the occurrence, habits, and effects of the Tsetse in the country to the south of the Zambesi, mentioning among other things an instance of acquired immunity to Tsetse-fly disease in the case of *Makoba* dogs, which "from time immemorial" have been bred by natives in the Fly country.

An early letter from Karl Mauch [36], the German pioneer-explorer of the gold-fields of the northern Transvaal and Mashuna Land, and subsequent discoverer of the ruins of Zimbabye, published in 1869, is interesting from the fact that it mentions an external application of Asafœtida, or internal application of ammonia as possible remedies for Tsetse bite. In the same year Mr. and Mrs. Petherick [37] encountered the Tsetse in the country of the Rhol Tribe, north-west of Gondokoro.

We now meet with the earliest expression of a certain scepticism as to the reputed effects of the bite of the Tsetse upon domestic animals, which, appearing first in the year 1870, continued side by side with the orthodox belief until well into the 'eighties. Mr. St. Vincent Erskine [38], an African traveller well known at the time, addressing a meeting of the Natural History Association of Natal on May 30, 1870, is reported to have "combated the popular idea that the bite of the Tsetse-fly was destructive to the life of certain animals, especially the ox, horse, and dog." Mr. Erskine's theory "was that the deaths of the animals were to be attributed more to change of grass or climate than to the bite of such a small fly as the Tsetse." No arguments are recorded in support of this belief, which is evidently due to a revolt against the popular idea already referred to, that the deaths of domestic animals bitten by the Tsetse were caused by a poison secreted by the fly itself. The belief in the existence of a specific *Tsetse poison* may be said to have prevailed until the publication of the results of Col. David Bruce's investigations in 1897 (see Chapter VII., Appendix A), though, as we shall shortly see, the true state of the case was

hinted at less than ten years after the date of Erskine's paper.* St. Vincent Erskine's theory, although attacked shortly afterwards by E. C. Buxton [41], was warmly espoused by the well-known English entomologist, Edward Newman [39, 44], who considered the Tsetse to be a "myth."

A second letter from Karl Mauch [40], published in 1870, contained an early expression of the commonly accepted idea that the donkey is immune to Tsetse-fly disease. Writing of the behaviour of a donkey in the Fly country in the Northern Transvaal, Mauch says:—"The main advantage, however, consisted in the fact that the Tsetse could not do her any harm, whether it be that the donkey finds in certain leaves or in the bark of certain trees an antidote against the poison, or that the long hair or the effluvium from the beast repels the insect." † In this letter Mauch also recorded the uselessness of sal ammoniac, administered internally, as an antidote to Tsetse-fly disease in cattle. A map by A. Petermann to illustrate Mauch's travels, published in the same volume as the letter, shows the "Limit of the Tsetse-fly" in the vicinity of the Limpopo, and also to the south of the Zambesi.

Eduard Mohr [42] met with the Tsetse in 1870 to the south of the Victoria Falls, but Otto Kersten [43], who took part in Baron C. C. von der Decken's travels in East Africa from 1859 to 1865, did not encounter it between the coast and Dschagga (the region of Mt. Kilima Njaro), though later on he mentions its occurrence on the Lower Juba River as the reason why the Wabuni, a scattered tribe of Galla, are unable to keep cattle.‡ Stanley [45], in "How I Found Livingstone," published in 1872, recorded his experience with Tsetse-flies, and mentioned native names under which they are known in different regions.

* Livingstone himself [21] appears to have partially realised the truth. After describing the effects of the bite of the Tsetse-fly in cattle, he proceeds to say ("Missionary Travels," p. 82):—"These symptoms seem to indicate what is probably the case, a poison in the blood; the germ of which enters when the proboscis is inserted to draw blood. The poison-germ, contained in a bulb at the root of the proboscis, seems capable, although very minute in quantity, of reproducing itself, . . ." It is evident, however, that Livingstone supposed the fly to possess a poison-gland, situated in the bulb at the base of the proboscis, the secretion of which was fatal to cattle.

† Col. Bruce's experiments showed that Tsetse-fly disease is invariably fatal to the donkey in Zululand (see Chapter VII., Appendix A).

‡ Probably this is the earliest definite reference to the Somaliland Tsetse-fly, described long afterwards by Corti as *Glossina longipennis:* if so it is interesting as evidence that a species of *Glossina* distinct from *Gl. morsitans* is able to carry the hæmatozoon. (*Cf.* Chapter VII., Appendix E.)

E. Marno [47], writing in 1873, stated that Tsetse-flies had been brought to him in Sennaar as being included among the flies known there by the name "Surrēta." * The occurrence of a species of *Glossina* in Sennaar, however, needs confirmation [*cf.* 12]. Marno adopted much the same view as St. Vincent Erskine [38—*vide supra*], expressing the opinion that the bites of flies, whether called Tsetse or Surrēta, are only one, and "perhaps even a subordinate factor," in causing the mortality among imported domestic animals, which occurs in certain parts of Africa either throughout the year, or only during the season called *Charif* in Sennaar, and is actually due to adverse climatic conditions.

"The Last Journals of David Livingstone" [49], edited by Horace Waller, and published in 1874, are of especial interest from our present point of view, since they contain the account of the buffalo and camel experiments already referred to. Unfortunately the experiments were to a large extent vitiated by the ill treatment of the animals by sepoys, whom Livingstone had brought with them from Bombay. The "Journals" contain many references to the Tsetse-fly on the Rovuma River and elsewhere. In the same year Karl Mauch [50] repeated the statement that donkeys and goats are immune to Tsetse-fly disease, and went on to say :—"Only one remedy appears to be effective, and that is based upon homœopathic principles ; the fly itself, taken internally, makes the punctures innocuous, as I have seen in the case of a dog, . . ." The use by natives of the Tsetse-fly itself as a means of making animals immune to the disease, has been referred to by various writers [*Cp.* 27, 30, 55, 97].

In 1876, E. Mohr [52] recorded an instance in his own experience of the apparently curative effect of an internal application of "strong doses of eau de l'huis, or extract of ammoniac," in the case of horses suffering from Fly disease, and also stated that goats are immune.

Dr. Hartmann [53], in the course of remarks on the Tsetse-fly addressed to the "Gesellschaft naturforschender Freunde" of Berlin, on July 17, 1877, mentioned the occurrence of a species of *Glossina* (considered by the lecturer to be identical with *Gl. morsitans*, Westw., but from his description almost certainly either *Gl. palpalis*, Rob.-Desv., or *Gl. longipalpis*, Wied.) in Loango,

* Blood-sucking horse-flies (*Tabanidæ*) are commonly spoken of as "Seroot" flies by Englishmen on the White Nile.

where he stated that Tsetse-fly disease was apparently unknown. The lecturer's views as to what he considered to be the exaggerated statements concerning the harmful effects of the bite of the Tsetse-fly, as also of the Diptera known under the name Surrita (and other variants of the same word), were identical with those of Marno (*vide supra*).

In 1877 Dr. Joseph Mullens [54] gave an account of an interesting experiment with draught oxen on the road between Saadáni and Mpwapwa, which seemed to have proved satisfactorily that the Tsetse-fly did not occur on that section of one of the possible routes to Lake Tanganyika. The same year saw the publication of Thomas Baines' "Gold Regions of South-Eastern Africa" [55], which gave numerous details as to the occurrence of *Glossina morsitans* in the Transvaal, with notes on the way in which it may be distinguished from other flies, the effects of its bite in cattle, as summarized by Henry Hartley, a well-known elephant-hunter and pioneer at that time, on the effects of the external application of ammonia as a remedy in the case of fly-bitten horses, etc. Baines included mules, donkeys, sheep and goats among the animals "believed to be unaffected by the virus," though he proceeds to add that mules are not always safe, and that "Mr. St. Vincent W. Erskine doubts the safety of the donkey on the south-east coast." From the latter remark it would appear that by this time Erskine had seen fit to change his ideas with regard to the effects of the Tsetse's bite.

In "Through the Dark Continent" [56], published in 1878, Stanley mentions having encountered the Tsetse during his journey down the Congo, on the islands below Rubunga. In a paper by F. B. Fynney [57], which appeared in the same year, the author stated that during the preceding six years the Tsetse had disappeared from many parts of the Transvaal, formerly known as Fly Country, and remarked that it was hardly necessary to attach so much importance to the presence of the Tsetse as was usually done, "because the fly is merely a temporary and ephemeral scourge, and always disappears with the large game."

The first definite suggestion of the true part played by the Tsetse-fly in connection with the disease which bears its name appeared in 1879, in the report of an address delivered by Dr. J. J. Drysdale [58] to the Literary and Philosophical Society of Liverpool, where it is stated that the Tsetse-fly "may be the intermediate host of some . . . . blood-parasite; or it may be the carrier of some infective poison. It is highly improbable

that any mere poison or venom should exist so powerful as to cause the death of a large animal in such small dose." It will be seen that in his first hypothesis Dr. Drysdale came very near the truth, though Col. Bruce's investigations, with the subsequent papers by Laveran and Mesnil [XXI.], and Plimmer and Bradford [XX.] on the life-history of *Trypanosoma brucei*, would seem to show that the Tsetse-fly is in no sense its host: recent German writers on Tsetse-fly disease, however, incline to the opposite view. As we shall find, between this date and that of Col. Bruce's memoir, various writers published notes expressing practically the same view as Dr. Drysdale concerning the etiology of Tsetse-fly disease.

Captain J. F. Elton [59], writing in 1879, mentioned the Tsetse as abounding near Livingstonia, at the south end of Lake Nyasa;* and in the same year Sir Rutherford Alcock [60] stated that the Tsetse-fly "on the road to Mpwapwa" had destroyed the draught cattle belonging to a party sent by the London Missionary Society to Lake Tanganyika [*Cf.* 54]. A note printed in the Proceedings of the Royal Geographical Society [62] about the same time records the fact that bullocks were working satisfactorily on the first section of the road then being made from Dar-es-Salaam to the interior, and adds, "It is therefore clear that there is no Tsetse-fly on the forty miles already traced of the route. . . ."† A letter published in "The Times," of February 25th, 1879, by Lewis Hornor [64] recommends the Boer method of crossing fly-belts at night—a mode of avoiding the attacks of the fly that, from the experience of subsequent travellers, is not invariably effective [*Cf.* 77, 110].

Various books and papers [66–75] published during the next two years (1880–1881), and dealing mainly with South Africa, contain statements of the occurrence of the Tsetse-fly in different localities.

Selous' "Hunter's Wanderings in Africa" [76], one of the classics of South African sport, and a paper on "The Tsetse Fly," by Dr. B. F. Bradshaw [77], both of which appeared in 1881, include many interesting details. The experience of both writers had been gained in the same country, *viz.*, the vicinity of the

* Sir Harry Johnston [145], writing in 1897, states that the south coast of Lake Nyasa is almost entirely free from Tsetse.

† *Cf.*, however [71], where it is stated that the Tsetse-fly occurs on this road forty miles from the coast, rendering the employment of horses and bullocks out of the question: "the belt of fly-country is, in fact, here wider and more continuous than it is further to the north."

Chobe and Zambesi, and therefore the species to which the statements of both refer is probably *Glossina morsitans*.

The failure, owing to Tsetse-fly, of the London Missionary Society's endeavour to use bullock waggons on the road to Lake Tanganyika in 1877 was recorded by E. C. Hore [78] in 1882, and the same writer also gave details of the occurrence of the fly on the shores of Lake Tanganyika itself. In the same year L. K. Rankin [79] described the results of a highly interesting attempt, which was considered to have resulted in success, to discover whether Indian elephants, employed as baggage-animals on the march from Dar-es-Salaam to Mpwapwa, would withstand the attacks of the Tsetse-fly—in this case probably *Glossina pallidipes*, Austen.

Dr. E. Pechuël-Loesche [80], writing in "Die Loango Expedition" (1882), stated that a Tsetse-fly had been collected near Tschintschōtscho, about a hundred miles north of the mouth of the Congo. The species is not mentioned, but possibly it was either *Gl. palpalis*, Rob.-Desv., or *Gl. longipalpis*, Wied. Since, however, cattle are kept both at Landana and Boma in the same district, and not only roam about freely, but also thrive tolerably well, either the fly does not occur near those towns or else the Trypanosome of Tsetse-fly disease is absent; or, if present, is not carried by the local Tsetse-flies.

In "The Wild Tribes of the Soudan," by F. L. James [81], published in 1883, mention was made of a disease called *guffer*, which attacks camels in the district to the east of Kassala, and was stated by some of the natives to be "caused by the bite of the Tsetse-fly during the rainy season." There is no record, however, of a Tsetse-fly actually having been captured in this region. In the same year a Swiss entomologist named Schoch [83], in a well-reasoned paper, advanced arguments for considering that the Tsetse-fly is not in itself poisonous, but "at most the carrier of a bacterium-like poisonous matter." Nearly every previous writer had referred to the Tsetse-fly as though but a single species existed, but Schoch speaks of "two long-winged Muscidæ of similar appearance, one as large as our house-fly, the other somewhat larger, and less dreaded." Apparently, therefore, the writer in question was acquainted with *Glossina fusca*, Walk., though he gives no authority for stating it to be "less dreaded" than *Gl. morsitans*. Various earlier writers had hinted at the probable disappearance of the disease, as the Tsetse either followed or became extinct with the big game, but Schoch

attained a higher and more scientific standpoint by his conclusion that, "with more intimate knowledge of the active principle, the disease can be successfully opposed, and will gradually disappear." Although this consummation has not yet been reached, and though no antitoxin for the effects of *Trypanosoma brucei* in domestic animals has so far been discovered, the lines of practical research were thus foreshadowed by Schoch a dozen years before it was actually attempted, and his name will deserve to be remembered when the investigations that are now being undertaken are at length crowned with success.

Passing over one or two records of the occurrence of the Tsetse in different localities, as well as another attempt to show that the belief in the harmfulness of the fly is mere prejudice [84], the next publication of importance appeared in the year 1884 in the shape of a paper on the Tsetse-fly, by the late Dutch entomologist, F. M. van der Wulp [88], which also included a short bibliography. From a report of further remarks by the same writer [91], published in the following year, it is evident that he sided with those who doubted the stories of the effects of the bite of the Tsetse-fly in domestic animals. In the same year the Austrian dipterist, Josef Mik, also recently deceased, in an abstract [90] of Schoch's paper pointed out the existence of what were supposed to be three additional species of *Glossina*.

Among records of the occurrence of Tsetse-flies in different localities, published during the year 1885, a paragraph in a paper by F. L. James [94], entitled, "A Journey through the Somali Country to the Webbe Shebeyli," is worthy of notice from three points of view. The writer states that the Adone, the people living on the Shebeyli, "have large herds of cattle and flocks of sheep, but all these animals are poor and suffer from the fly in the rain and from the ticks in the dry season; neither camels nor horses are used, for they will only live in the dry season. . . ." In this passage the Tsetse is not referred to by name, but we now know that *Glossina longipennis*, Corti, the Somaliland Tsetse-fly, occurs on the Webbe Shebeyli, and it would seem, therefore, that we have here a definite indication that the species in question is a carrier of the hæmatozoon. Secondly, the statement that *sheep* suffer from the attacks of the fly is of interest, since various writers have mentioned *native* sheep and native goats as animals immune to Tsetse-fly disease.*

* Col. Bruce was unable to obtain native sheep and goats for his experiments in Zululand.

The mention of ticks is of interest in connection with the knowledge that the parasite of Texas fever among cattle is disseminated by these animals; although it is scarcely likely that ticks can act as carriers of Tsetse-fly disease, it would perhaps be worth while to settle the point by actual experiment.

"De Angola Á Contra-Costa," by H. Capello and R. Ivens [96], published in 1886, contains a chapter (illustrated with rough wood-cuts of the head and foot enlarged) on the Tsetse-fly, entitled "A Tzé-Tzé"; but, since it is in Portuguese, the present writer has unfortunately been unable to examine its contents. In the same year interesting details of the occurrence of the Tsetse in Mashuna Land and the region between the Zambesi and Lake Nyasa were given by W. M. Kerr [97, 98] who also described the means adopted by the native women in Mashuna Land for making dogs, goats, and sheep—"of which they have very few, seemingly only kept as pets"—immune to Tsetse-fly disease when young.

In 1887 Josef Chavanne [99] declared that the Lower Congo must be free from Tsetse-fly, since cattle throve fairly well in that region. The same year saw the publication of the second edition of Justus Perthes' special large-scale map of Africa, in which the limits of the Tsetse-fly in the vicinity of the Limpopo are indicated by dotted lines. In 1887, too, Dr. C. W. Schmidt [101] recorded the fact that the Tsetse-fly did not occur in the districts of Usambara and Bondei, near the Pangani River, German East Africa, and that consequently it was possible to keep cattle on a large scale in Usambara.*

The ranks of those who considered that the disease produced by the bite of the Tsetse-fly in domestic animals was not due to a poison secreted by the fly itself received a further accession in 1888, when A. Laboulbène [102] expressed the opinion that the Tsetse "carries with its proboscis septic matter drawn from diseased animals, and communicates it to others that are healthy, the result of which is illness and possible death. It remains to be explained why the bite, which is said to be deadly to cattle, is not so to human beings." In the same year, in a communication to the Royal Geographical Society from Dr. Holub [104], allusion was made to the abundance of Tsetse-fly in forests, consisting of small trees, in the Batoka country; F. Jeppe [105] recorded the partial disappearance of the fly,

* A recent paper by Stuhlmann [XXVI.] would seem to show that nowadays, at any rate as regards Usambara, this is a mistake.

together with the big game, from the Kaap Valley in the Transvaal, as a result of gold-mining operations; and the ninth edition of the "Encyclopædia Britannica" gave a short résumé of existing knowledge of *Glossina morsitans*, and its distribution.

In 1889 the occurrence of "a yellowish-brown *Glossina*" (doubtless *Gl. fusca*, Walk.) in the forest at Barombi Station, Cameroons, was recorded by Dr. Preuss [107]; and in 1890 Dr. Holub [110] gave a number of details of the occurrence and effects of the Tsetse in the region of the Zambesi. Among other statements, Dr. Holub gave his reasons for thinking that, under certain circumstances, trekking at night with waggons through a fly-belt may not be such a safeguard as is generally imagined, and also expressed the opinion that the diminutive size of the cattle kept by the Matoka is due to the influence of the fly.

"Ten Years in Equatoria," by Major Gaetano Casati, published in 1891, contains the statement that the raising of cattle by the Mambettu, a tribe living to the west of Lake Albert Nyanza, is impossible owing to the presence in their country "of a fly called *Tsetse*, the stings of which cause death . . . ." In the same year E. A. Maund [112], writing "On Matabele and Mashona Lands," repeated the oft-made assertion that the Tsetse is destined to disappear with the game, and also mentioned the fact, previously recorded by Kerr (*vide supra*), that the Mashonas administer the dried and pounded fly to their dogs as a prophylactic against the disease. According to Maund the medicine is given on the extremely restricted scale of "a fly a day"!

Captain (now Sir) F. D. Lugard [115] writing in 1893, emphasised the superior advantages possessed by British East Africa over South Africa, owing to the fact that the former country is "practically free from the Tsetse-fly." He also showed that German East Africa is much worse off, since there, according to Dr. Pruen, "the Tsetse-fly holds undisputed sway" throughout the whole of a broad zone bordering the coast: the fly-belt known to exist near Taita is then discussed. It is perhaps worth while to remark that the knowledge accumulated since the publication of Sir Frederick Lugard's book shows that, especially in the north-eastern portion of British East Africa, the Tsetse-fly is more prevalent than the distinguished administrator supposed.

During the same year (1893) there appeared a number of other records of the occurrence of Tsetse-fly in various localities, chiefly in East and South-east Africa. The late Mr. Theodore Bent [116], in a newspaper interview, mentioned the importance of the Beira Railway, in rendering it possible to cross without difficulty the Tsetse belt through which it passes; while Major J. J. Leverson [118] gave his experience of the fly in the same region, on and near the Pungwe River. Mr. F. J. Jackson, C.B. [119], also in a newspaper interview, discussed the merits of alternative routes to Uganda, with special reference to the presence or absence of the Tsetse-fly, which, as was also stated by Captain Foster [120], infests some sixty miles of the Sabaki River route, near the Tsavo. Mr. F. C. Selous [121], in his volume entitled "Travel and Adventure in South-East Africa," gave numerous details of the occurrence of the fly in Southern Rhodesia; and the existence of two species of *Glossina* in the hinterland of the German Protectorate of Togo, West Africa, was recorded by Dr. Karsch [122].

In a letter from Dr. Donaldson Smith [124], published in 1894, mention is made of "the dreaded camel-fly of the Webi Shebeli"—doubtless the same species as that referred to nine years earlier by Mr. F. L. James [94—*vide supra*]. In the same year Commissioner (now Sir Harry) Johnston [125] dealt with problems raised by the presence of Tsetse-fly in British Central Africa, while its occurrence in British East Africa was referred to by Sir Gerald Portal [126] and Mr. F. J. Jackson [127]. The latter writer mentioned the interesting fact that, although it is supposed by many people that the Tsetse exists only "where game beasts, especially buffaloes, are most plentiful," and though this may be the case in South Africa, in East Africa at any rate the fly-belts, "with the exception of the River Tana," "are almost devoid of game."* The late William Cotton Oswell [128], writing in the same volume as Mr. Jackson on "South Africa Fifty Years Ago," mentioned his experience of *Glossina morsitans* in that region in the middle of last century, when he hunted with Vardon and was the companion of Livingstone on his earlier travels.

In 1894, too, Jules de Guerne [129] allied himself with Schoch [83—*vide supra*] by stating that:—"Everything leads

* For further information as to the ability of Tsetse in East Africa to exist independently of game, the reader is referred to the letter from Mr. Jackson printed in Chapter VII., Appendix C, p. 295.

us to believe that *Glossina* inoculates domestic animals with the germs of some virulent malady analogous to anthrax."

The year 1895 witnessed the publication of Surgeon-Major (now Lieut.-Col.) Bruce's "Preliminary Report on the Tsetse-fly Disease" [131], which afterwards was practically embodied in his "Further Report" of two years later. In 1895, too, one or two interesting notes on different species of Tsetse-flies appeared in the *Geographical Journal*. What appears to have been the Somaliland Tsetse-fly [*vide supra*, and 94 and 124], *Glossina longipennis*, Corti, is recorded to have been met with in the previous year in the Korayo Valley, Somaliland, where its bite proved fatal to baggage animals belonging to Major Mainwaring [133]. The second note, by W. A. Eckersley [134], refers to Tsetse-fly in connection with the Beira Railway, then in course of construction. The fly is stated to have made its appearance at Chimoio, in Portuguese East Africa, as a result of the presence there "of a large number of horses, oxen, and other animals . . ., attracted thither by the facilities of transport offered by the railway . . . ." Another interesting statement by Mr. Eckersley is that a couple of ponies, "purchased in Natal for the use of the survey party, passed through Beira, Fontesvilla, and the intervening 'fly-belt,' to Chimoio without suffering any ill effects; they served the party until the conclusion of the work, and were finally sold at a profit. No particular precautions against the 'fly' were adopted, except occasional brushing with green boughs. It is quite certain that the Tsetse-flies settled on the horses in considerable numbers, and remained quite long enough to allow of their biting." Since it is stated that the country traversed by the first twenty miles of the railway was, at the period referred to, "teeming with big game, including lions, buffaloes, most of the South African species of antelope, wart hogs and wild boars," it would almost seem as though the hæmatozoon of Nagana must, for some reason or other, have been absent from the blood of the wild animals near the course of the line.

M. Édouard Foà's volume [135] on his experiences of big game shooting, also published in 1895, contains many observations on the Tsetse-fly, including an interesting description of its method of feeding.

In the following year a review of Bruce's "Preliminary Report" was published by W. F. H. Blandford [136], who laid stress on the importance of studying the bionomics of the para-

site rather than continuing investigations upon purely clinical lines. Other publications of the year 1896 worthy of notice from our present point of view are a further Report by Sir Harry Johnston [138] dealing with the British Central Africa Protectorate, and "The Great Rift Valley," by Dr. J. W. Gregory [139]. According to Sir Harry Johnston the Tsetse-fly is already fast disappearing from British Central Africa, and "the unchecked increase of the negro population" should be encouraged as a means of hastening its "entire extinction." Dr. Gregory described how, in the Tsetse-haunted belt of forest between Witu and the coast, he endeavoured to protect his camels by the Galla method of raising clouds of smoke.

With the publication in 1897 of Col. David Bruce's "Further Report on the Tsetse-Fly Disease or Nagana, in Zululand" [142], not only was the disease conclusively proved to be due to a hæmatozoon, but also, by means of a brilliant series of preliminary experiments, the part played by the Tsetse in transmitting the malady was finally established. Since the Report will be found fully analysed elsewhere (see Chapter VII., Appendix A), there is no need to say more about it here.

From this time onward the literature of the Tsetse-flies consists mainly of statements in books of travel and Government Reports. These statements contain much additional information as to the geographical range of the genus *Glossina*, but do not add greatly to our knowledge in other respects. Of the further contributions furnished by the year 1897, the most important is that contained in Sir Harry Johnston's work entitled "British Central Africa" [145], wherein several pages are devoted to the Tsetse-fly. The problem raised in West Africa by the occurrence of several species of *Glossina* was alluded to in the same year by the late Miss Mary Kingsley [148], who pointed out that it would be useless to make a practicable road for draught animals from the Gold Coast to its hinterland, "because of the horse-sickness and Tsetse-fly which occur as soon as you get into the forest behind the littoral region." . In the course of remarks on the Tsetse-fly in "The New Africa," by Messrs. Schulz and Hammar [149], also published in 1897, the interesting statement is made that in 1874 donkeys safely performed the journey from Delagoa Bay to Lydenburg, in the Transvaal, "when that country was thickly infested with flies that killed cattle, horses, and even the few camels that were imported as an experiment." It is admitted, however, that donkeys succumb like other animals

when the Tsetse is present in overwhelming numbers. Further on it is stated that the goats which the authors had with them showed no signs of being affected by the fly, and their immunity to the disease is considered to be established.*

The deaths of cattle and horses from the bites of Tsetse-flies in the Aulihan country, Somaliland, in January, 1896, was recorded by Prince Nicholas Ghika [150] in 1898. In the same year Mr. A. H. Neumann [151], in his volume on "Elephant-Hunting in East Equatorial Africa," stated his experience of Tsetse-flies in British East Africa and on the shores of Lake Rudolph; in the latter locality he encountered one of the larger species, doubtless *Glossina fusca*, Walk. Captain Gibbons [152] gave many details as to the occurrence of the Tsetse in Rhodesia, and both this writer and Captain the Hon. Arthur Lawley [153] —the latter in a magazine article referring to the same country— dwelt on the close association of the Tsetse with the big game. According to Captain Gibbons, "where the wild buffalo is to be found in large numbers the Tsetse invariably teems"; while Captain Lawley states that in the neighbourhood of the River Deka, since the game has been nearly exterminated by rinderpest, "the fly also has left the country, excepting a few belts of thick bush, and apparently it is gradually disappearing." As we have seen, according to Mr. F. J. Jackson [127, *vide supra*], the fly in East Africa is not so intimately associated with big game. Other contributions in 1898 included notes by Mr. W. W. A. Fitzgerald [154] on the Tsetse-fly in the coast lands of British East Africa; and some interesting observations in a Government Report on the progress of the Uganda Railway [155], in which it is stated that, of the transport animals engaged in supplying the advanced parties with food and water mules were found less susceptible to Tsetse bite than either camels, donkeys, or bullocks. In the same year Dr. Garry de N. Hough [156] identified two specimens collected by Dr. Donaldson Smith in Somaliland in August, 1894, as *Glossina longipennis*, Corti.; while a short article in the "Globe" newspaper [157], of July 11th, 1898, stated that a malady, which had "played havoc" with the horses and transport animals of the Royal Niger Constabulary at Lokoja, had been identified as Tsetse-fly disease. It was also

* The question of the immunity of the goat to Tsetse-fly disease has long been a moot point, though more than twenty years ago it was stated by Selous [76] that goats, other than animals whose ancestors had been bred in the Fly-country for generations, enjoy no special immunity whatever.

stated that "the Lokoja natives, knowing nothing of microbes and bacteria, assert that the fly extracts from a certain small red monkey the virus with which it inoculates the bush cow or dwarf buffalo." Though this is very possibly a simple folk-tale, it perhaps suggests the advisability of examining the blood of the South African baboon (*Papio porcarius*, Bodd.) to see whether *Trypanosoma brucei* can be detected in it.

Among contributions published in 1899, we may notice a statement contained in Sir Harry Johnston's "History of the Colonization of Africa by Alien Races" [160], with reference to the destruction, apparently by the Tsetse-fly, of the horses and camels of an early Portuguese expedition which proceeded from Quelimane to Sena in 1569. This has already been alluded to at the commencement of this chapter (see p. 31). In 1899, too, W. Harvey Brown [161] wrote of the difficulty caused by the Tsetse-fly in the importation of machinery into many of the mining districts of Rhodesia, before the construction of the Buluwayo Railway; while the present writer reported the occurrence of *Glossina longipalpis*, Wied. (really *Gl. palpalis*, Rob.-Desv.), in the vicinity of Freetown, Sierra Leone.

In 1900 Mr. C. V. A. Peel [163] narrated his experience of *Glossina longipennis* in Somaliland, and gave an interesting description of the sensation of suddenly entering a "fly-belt." In the same year Mr. H. A. Bryden [165] repeated the statement of so many previous writers on sport in South Africa, by asserting that "wherever the African buffalo is plentiful, there you will almost certainly find the Tsetse-fly," adding that when the buffalo was killed off or driven out the fly disappeared. The Bushman story that the fly breeds in buffalo droppings is referred to as possibly accounting for its special association with the animal, but since Bruce's description of the mode of reproduction we know that belief to be a myth. According to Bryden, a line of coaches from the Pungwe River towards Mashonaland, established "when Rhodesia was first being opened up," had to be abandoned owing to the deaths of the horses and mules from the bites of the Tsetse-fly.

In 1901 Sir Harry Johnston [166], in a Report on the Protectorate of Uganda, referred to the length of time formerly taken on the journey to that country from the coast before the construction of the Uganda Railway, since it "had to be performed mainly on foot owing to the difficulty of conveying riding animals through the belt of country near the coast infested with the

Tsetse-fly." In the same year Dr. Max Schoeller [167], writing on German East Africa, suggested that should the domestication of zebras for transport purposes prove feasible, those animals would be of much more use than horses or donkeys owing to their immunity from Tsetse-fly disease. Dr. Schoeller also discussed the question of the possible identity with the Tsetse of the "Wandorobo-fly" of the Wadschagga, the bite of which was stated by the latter to have been responsible for the death of his donkeys, though attempts to obtain specimens of the fly proved unsuccessful. The author in question seems inclined to believe that his donkeys really died from a form of the disease known to the Boers as "Dikkopziekte"—the South African horse-sickness. Among other publications of 1901 to be noticed, is a "Report by His Majesty's Commissioner on the East Africa Protectorate" [168], in which it was stated that since the advent of the Uganda Railway horses can be brought up from the coast to Ukamba for travelling purposes, while formerly it was the custom in that country "to make long marches on foot," owing to the impossibility of conveying horses from the coast through the intervening Fly-belts. The Commissioner supports Dr. Schoeller [167, *vide supra*] by advocating the domestication of the zebra and the wildebeeste, and for the same reason, adding that "the prosperity of the country is at present sadly hampered by want of efficient transport." In the same year Mr. and Mrs. Hinde [169], in "The Last of the Masai," expressed the fear that the establishment of the Uganda Railway might contribute towards the final extinction of big game "in the last stronghold left in Africa," since now that the barrier formed by the Tsetse-fly was no longer an obstacle it was possible for "sportsmen" to enlist the aid of the horse. Towards the end of 1901 Dr. Schilling [170] recorded the presence of a disease which is fatal to horses and is called by Schilling "Surra" (no doubt in agreement with Koch, who pronounced Tsetse-fly disease in East Africa to be identical with Surra in India), in the German Protectorate of Togo, on the Slave Coast, West Africa, where, as is shown in Chapter IV. of the present work, *Glossina morsitans* occurs, as well as *Gl. palpalis* and *Gl. fusca*. Schilling was unable to make experiments with the fly, but described the Trypanosome which causes the disease.

Turning to the year 1902, an important work by MM. Laveran and Mesnil [171] must be noticed, since besides treating of the hæmatozoa of Nagana and kindred diseases, it contains

various statements on the distribution of Tsetse-flies and of the eponymic malady disseminated by them. From Sir Harry Johnston's great work on "The Uganda Protectorate" [172], published a few months ago, it appears that although "flies of the genus *Glossina*"* are found in that country, Tsetse-fly disease is absent, a statement that suggests the advisability of prosecuting a careful enquiry into the geographical distribution of *Trypanosoma brucei* without delay.† Reference may also be made to a recent statement by Mr. J. N. Justice [173], who, in a paper on "Prospecting in Northern Rhodesia," mentions that, according to the natives, "since the rinderpest exterminated the buffalo, the Tsetse has lost much of its venom. . . ." This is merely a reassertion in another form of the old stories of the specially close connection between the Tsetse and the buffalo, which, as may be seen from the letters printed in Chapter VII., Appendix C, is not admitted as regards East Africa by some of those best qualified to express an opinion on the subject. Finally, we may notice two papers [XXVI., 174], by Dr. Franz Stuhlmann on Tsetse-flies (*Glossina morsitans* and *Gl. fusca*) and Tsetse-fly disease (which the author, like other recent German writers, calls "*Surrah*") in German East Africa; in the former paper Dr. Stuhlmann gives a map to illustrate the occurrence of the disease in the region in question.

In conclusion, then, it will have been seen from the foregoing résumé, that while in the space of sixty odd years our knowledge of the Tsetse-flies has gradually increased, we have still much to learn. It is only within the last few years that the remarkable mode of reproduction has been made known, and it has yet to be discovered whether this is the same in all species. Very little is known as to the distribution of certain species; and, most important of all, we are still in almost complete ignorance as to whether all the species are equally capable of conveying the parasite of Tsetse-fly disease (*see* Chapter VII., Appendix E, p. 300).

II.—Systematic.

Although the name "Tsetse" did not become generally known in England until the year 1850, when the habits and ravages of "the fly called 'Tsetse'" were mentioned by R.

* Probably *Gl. fusca*, Walk., and perhaps *Gl. pallidipes*, Austen.

† *Cf.* Chapter I., p. 30, note †.

Gordon Cumming [9], while the species to which the name was first applied was soon afterwards described by Westwood [10] under the well-known designation *Glossina morsitans*, the genus *Glossina* dates from twenty years earlier. In the year 1830, therefore, the genus *Glossina* was founded by Wiedemann [2] for his species *Gl. longipalpis*, the type of which was stated to have been obtained at Sierra Leone by Adam Afzelius.*

In the same year, 1830, a second species of Tsetse-fly was described by Robineau-Desvoidy [3] from a specimen from the Congo, under the name *Nemorhina palpalis*. It has since been customary among Dipterological writers to regard *Nemorhina palpalis*, Rob.-Desv., as a synonym of *Glossina longipalpis*, Wied.; but, as is shown in Chapter IV., the two species are really quite distinct. This raises the question of priority between *Glossina* and *Nemorhina*, since both names date from the same year: the question, however, in default of anything in the shape of internal evidence, is now incapable of solution, and in the present work no attempt has been made to upset existing nomenclature so far as the genus is concerned, since to abolish a name so well established in literature as *Glossina* would be for every reason eminently undesirable.

After 1830 no addition was made to the genus *Glossina* for a space of nineteen years, until in 1849 *Glossina fusca* (*Stomoxys fuscus*) was described by Francis Walker [7], from a single female from an unknown locality. In 1873 this species was sunk by its author [46] as a synonym of *Gl. longipalpis*, Wied., though, as is shown in the systematic portion of this work (Chapter IV., p. 100), it is in reality perfectly distinct and must be maintained.

The next species to be described were *Glossina morsitans*, *tachinoides*, and *tabaniformis*, all of which date from Westwood's paper in the Proceedings of the Zoological Society for 1850 [10]. Of these three species, as is shown in Chapter IV., *Gl. tachinoides*, from West Africa, is nothing more than a variety of *Gl. palpalis*, Rob.-Desv., while *Gl. tabaniformis*, from the Gold Coast, is a synonym of *Gl. fusca*, Walk.

After the appearance of Westwood's paper came an interval

* A Swedish botanist, who visited what was at that time the newly-founded settlement of Freetown, Sierra Leone, so long ago as 1792 and 1794, and made general collections of objects of Natural History. The existence of a Tsetse-fly in Sierra Leone was not recognised, however, until the present writer found *Gl. palpalis*, Rob.-Desv. (at the time supposed to be *Gl. longipalpis*, Wied.) there in 1899.—*Cf.* [162].

of five-and-thirty years, during which no addition was made to our systematic knowledge of the genus *Glossina*, though in the Appendix to Oates' "Matabele Land and the Victoria Falls" [73] a coloured figure of *Gl. morsitans*, and details of the antenna, mouth-parts, and tarsus were given by Westwood [74]. In 1885 a supposed new species of *Glossina* was described by the late Mons. J. M. F. Bigot [89], under the name *Gl. ventricosa*, and the description was preceded by a table (in French) for the determination of this and five other previously described species of Tsetse-flies. The writings of this author, however, were seldom distinguished by critical acumen, and the table in question, being based merely upon descriptions, is of little value. As to *Glossina ventricosa*, an examination of the typical specimens shows that they are nothing more than examples of *Gl. palpalis*, Rob.-Desv., with their abdomens distended with coagulated blood. Bigot's suggestion that his supposed new species hails from *Australia* will be found discussed below under Gl. palpalis—"Synonymy and Affinities" (Chapter IV., p. 78): as will be seen, there are in reality no grounds whatever for supposing that *Glossina* occurs outside Africa.

The next two species of *Glossina*—*Gl. grossa* and *Gl. pallicera*—were described, likewise by Bigot [113], in 1891. The types of both of these are from Assinie, Ivory Coast, and their author suggested that both might be merely varieties of *Glossina longipalpis*, Wied., by which he meant *Gl. palpalis*, Rob.-Desv.; but, as will subsequently appear (Chapter IV.), *Gl. grossa* is actually a synonym of *Gl. fusca*, Walk., while *Gl. pallicera* is a perfectly good species.

Of the remaining species, *Glossina longipennis*, Corti, the Somaliland Tsetse-fly, was described [130] in 1895 from a specimen from the Boran Galla country, on the confines of Abyssinia and Somaliland; while the last on the list, *Glossina pallidipes*, is now described in Chapter IV. for the first time, having hitherto been confounded with *Gl. morsitans*, Westw., with which it is apparently associated to some extent in geographical range.

CHAPTER III.

SYSTEMATIC POSITION OF THE GENUS.

The object of the present treatise being essentially practical, it would be out of place to enter at length into questions of classification; but enough must be stated to enable the reader to understand what are the nearest allies of the Tsetse-flies among existing insects. Suffice it then to say at once that the genus *Glossina* belongs to the calyptrate division of the Family Muscidæ (Muscaria Schizometopa, of Brauer and von Bergenstamm) of the Order **Diptera,** or Two-winged Flies. Diptera may be characterised shortly as insects with only one pair of wings, a thorax fused into a single mass, and mouth-parts adapted for piercing and sucking, or for suction alone. The metamorphosis is complete; the larvæ are totally different in appearance from the perfect insects, and, though varying greatly in outward form, are usually footless grubs; those of the Muscidæ are generally known as maggots. The pupa either shows the appendages of the perfect insect, although these are enclosed in a sheath and adherent to the body, or else it is entirely concealed within the hardened and contracted larval integument, which forms a protecting case. Diptera have been divided by Professor Brauer into two great groups, termed Orthorrhapha and Cyclorrhapha, according to the manner in which the pupa-case splits to admit of the escape of the perfect insect. In the Diptera Orthorrhapha, which include the less specialised families, such as the Cecidomyidæ (Gall-Midges), Mycetophilidæ (Fungus-Midges), Culicidæ (Gnats or Mosquitoes), Tipulidæ (Daddy Long-Legs), Tabanidæ (Horse-flies), Asilidæ (Robber-flies), etc., the pupa case splits longitudinally down the median dorsal line. In the Diptera Cyclorrhapha, on the other hand, which comprise the most highly specialised families, such as the Syrphidæ (Hover-flies), Œstridæ (Bot- and Warble-flies), and Muscidæ (*sensû latiore* —House-flies, Tsetse-flies, Blue- and Green-bottle-flies, Flesh-

flies, Flies of which the larvæ are internal parasites of caterpillars, etc.), the imago is enabled to escape by the splitting off of a cap from the cephalic end of the puparium.

The family Muscidæ in its widest sense is by far the most numerous in genera and species of the whole order. It is divided into two main divisions, Calyptratæ and Acalyptratæ; in the former of these the *squama*, or membranous scale, situated on the thorax behind and beneath the base of the wing, is sufficiently large to conceal the *halter*, the little club-shaped organ that projects beneath it; in the Acalyptratæ, on the other hand, the squama is so reduced in size that the halter is not concealed when the insect is looked at from above. The Muscidæ Acalyptratæ include a very large number of small flies, in which there is a great diversity of habits, especially in the larval state, though the majority of the perfect insects resemble the Common House-fly more or less closely in outward form, though not necessarily in colour or markings. The group is split up into a number of sub-divisions, which are regarded by some writers as sub-families, while others assign to them at all events nominal family rank. The Muscidæ Calyptratæ are generally speaking flies of larger size and stouter build than the Acalyptratæ. The group is divided into a smaller number of sub-divisions than the Acalyptratæ, and in its widest sense (= Muscaria Schizometopa, of Brauer and von Bergenstamm), includes the nominal families Tachinidæ (bristly flies, the larvæ of which are parasitic in caterpillars and certain other insects), Dexidæ, Sarcophagidæ (marbled grey Flesh-flies), Muscidæ (House-flies and their blood-sucking allies belonging to the genera *Stomoxys*, *Hæmatobia*, *Lyperosia* and *Glossina*, Blue-bottles, Green-bottles, etc.), Œstridæ (Bot- and Warble-flies), and Anthomyidæ (non-bristly Muscidæ, in which the first posterior cell of the wing is wide open).

While there can be no doubt that it is impossible to find hard and fast characters, which would warrant the maintenance of the independence of the six so-called families that have just been enumerated, there is fortunately no occasion to enter here into the vexed question of Muscid taxonomy, which has engaged the attention of various well-known dipterists during the last few years. As has already been pointed out by the late F. M. van der Wulp,* the genus *Glossina* was placed by its founder, Wiedemann, in the immediate neighbourhood of *Stomoxys*, Geoff., and if we add to the group *Hæmatobia*, Rob.-Desv., *Lyperosia*, Rond.,

* "Tijdschrift voor Entomologie," xxvii. (1884), p. 144.

and *Beccarimyia*, Rond., the nearest allies of the Tsetse-flies have been designated. The genera *Stomoxys* and *Hæmatobia* include several species of small brownish or mottled grey and brown flies, with a prominent though short chitinous proboscis, which are greedy blood-suckers, and plague both men and cattle. *Stomoxys calcitrans*, Linn., which is the only European species of its genus, though others occur in Africa, is very common in England in August and September, sitting about in numbers on rails and gates in fields. *Hæmatobia stimulans*, Mg., and *Lyperosia* (*Hæmatobia*) *irritans*, Linn., are common summer plagues of cattle in England; and the latter, known to American writers as *Hæmatobia serrata*, Rob.-Desv., has been introduced into the United States, where, owing to its habit of clustering about the bases of the horns of cattle, it is commonly called the "Horn-fly." Another species of *Lyperosia*, closely allied to *L. irritans*, but smaller and with narrower palpi, was found by Mr. W. R. Ogilvie Grant swarming on his camels in the Dimichiro Valley, Sokotra, in January, 1899.* The genus *Beccarimyia*, founded by Rondani,† for the new species *B. glossina*, from Keren, about seventy miles from Massowah, differs from *Hæmatobia* and the other genera in having a very prominent epistoma, and the first posterior cell of the wing closed before the margin.

The genus *Glossina* is placed by Brauer and von Bergenstamm ‡ in the "Subsectio Stomoxys," of the "Sectio Muscina." § The other genera of which the "Subsectio Stomoxys" is formed are: *Beccarimyia*, Rond., *Stomoxys*, Geoffr., *Hæmatobia*, Rob.-Desv., and *Lyperosia*, Rond.; the latter, which is sometimes regarded as a sub-genus of *Hæmatobia*, was founded‖ for *Conops* (*Stomoxys*, *Hæmatobia*) *irritans*, Linn. There is no doubt that this grouping represents the most commonly accepted ideas of the affinities of *Glossina*. In respect of certain structural details (*e.g.* the venation

* *Lyperosia minuta*, Bezzi ("Ann. Mus. Civ. Genov.," xxxii. (1892), p. 192), occurs in Somaliland, and two other species are found in Ceylon. One of the latter, which closely resembles *L. minuta*, Bezzi, but is probably new, has recently been stated to be very troublesome to ponies at the Ceylon breeding station.

† "Annali del Museo Civico di Storia Naturale di Genova," iv. (1873), p. 287.

‡ "Vorarbeiten zu einer Monographie der Muscaria Schizometopa (exclusive Anthomyidæ), Pars III.": "Denkschriften der mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften," lx. Band, Wien, 1893, pp. 177-178.

§ Subsequently termed by Prof. Brauer ("Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien," Jahrgang 1893, p. 516), the "Sectio Musca."

‖ Rondani, "Dipterologiæ Italicæ Prodromus," Vol. I. (1856), p. 93.

of the wings, the branched hairs on the arista, the bulb at the base of the proboscis, and the remarkable male genitalia), *Glossina* occupies a position altogether unique.* On the other hand, if we consider the characters afforded by the proboscis and the feathering of the arista, the affinity between *Glossina* and the genera with which it is associated in the system of Brauer and von Bergenstamm appears to be incontestable. The blood-sucking habit is common to all, and correlated with this we find a rigid, horny proboscis, which is carried in a horizontal position. The palpi, however, which in *Glossina* are so remarkably modified to form, in the living insect, a perfect sheath for the proboscis, are in *Stomoxys* of the ordinary Muscid type, being exceedingly slender, short (not projecting beyond the buccal cavity), and in no way affording any protection to the proboscis. In *Hæmatobia*, as represented by *H. stimulans*, Mg., the palpi, while apparently capable of forming a partial sheath for the proboscis, are distinctly shorter than that organ and expanded at the tips, while the tip of the proboscis itself bears a few short hairs, and the modified fleshy labella are plainly visible—as, though on a smaller scale, they also are in the proboscis of *Stomoxys*. So far as can be judged from Rondani's description and figure,† the palpi and proboscis of *Beccarimyia* resemble those of *Hæmatobia stimulans*, though the palpi do not appear to be expanded at the tips. Lastly, in *Lyperosia*, Rond., as represented by *Lyperosia* (*Hæmatobia*) *irritans*, Linn., of Europe and North America, the palpi, though flattened from side to side, as in *Glossina*, are not expanded at the tips, while they form a complete sheath for the proboscis, which they equal in length. As to the proboscis itself, though the tip still bears a few minute hairs, the labella are so reduced as to be practically invisible, their position, when examined under a low power, being merely indicated by a slight constriction, as in the case of the proboscis of *Glossina*.

So far as regards proboscis and palpi, therefore, *Glossina* approaches *Lyperosia* more nearly than any other genus yet mentioned. Moreover, in *Hæmatobia* the arista bears three or four short hairs on the under side as well as those on the upper, but *Lyperosia*‡ agrees with *Glossina* in having the arista feathered

* The aberrant mode of reproduction described by Col. Bruce (*cf.* Chapter I., p. 24) forms a further proof of divergence, and constitutes an approximation, so far as it goes, to the group of Diptera known as the PUPIPARA (*Hippobosca*, *Ornithomyia*, etc.).

† "Ann. Mus. Civ. Genov." iv. (1873), p. 287.

‡ As also *Stomoxys*.

only on the upper side; while in the closeness of the feathering and the curvature of the hairs on the arista *Lyperosia* also approaches more nearly to *Glossina* than does *Hæmatobia*.

In the general shape of the head, on the other hand, and in the relative width of the front in the male, *Glossina* agrees better with *Stomoxys* than with any of the other genera already referred to, while differing from all of them in having the vibrissal ridges ciliated nearly to the middle, and in being destitute of post-humeral bristles.*

According to Girschner's most recent exposition of his system for the classification of the Muscidæ,† *Glossina* and its allies belong to the "Section *Muscinæ ariciæformes*" of the Family Anthomyidæ (Girschner, *nec Auct.*). In an earlier paper by the author in question,‡ it is stated that the primary object of the macrochætæ (large bristles) on the pleuræ of Muscids is the protection of the stigmata or respiratory apertures. The Calyptrate Muscidæ may be divided into two great groups according to the presence or absence of macrochætæ on the hypopleuræ, protecting the metathoracic stigma;§ and *Glossina* and its allies belong to the group, which also includes the Anthomyinæ of authors, in which the hypopleuræ are bare. From the generalisation that, "We may rightly regard those forms as the more perfect (evolved at a later date), that, while having a similar mode of life, are provided with the best protective arrangements,"‖ Girschner proceeds to argue that the allies of *Cænosia*, *Aricia*, *Anthomyia* and *Cyrtoneura* (the group, therefore, that in his system would include *Glossina*) are on a lower developmental plane than, *e.g.*, the allies of *Sarcophaga*, *Dexia*

* The term *post-humeral* is here employed in the sense in which it was originally used by Mik ("Verh. z.-b. Ges. Wien," xxx. Bd., Jahrg. 1880 (1881), p. 350, fourth line from the top), and afterwards by Girschner ("Berl. Ent. Z." xxxviii. Bd. (1893), p. 298), and Hough ("Proc. Acad. Nat. Sci. Philadelphia," 1898, p. 176); not as used by Osten Sacken ("Essay of Comparative Chætotaxy," "Trans. Ent. Soc. Lond." 1884, p. 508): *cf.* Mik, "Verh. z.-b. Ges. Wien," xxxii. Bd. (Jahrg. 1882), p. 13. *Osten Sacken's post-humeral* bristles are in the present work termed *notopleural*, in accordance with Girschner (*loc. cit.*).

† E. Girschner, "Ein neues Musciden-System": "Illustrierte Wochenschrift für Entomologie," I. Bd. (1896), pp. 12–16, 30–32, etc. (Classification of Muscidæ according to setæ, etc., characters of families).—Unfortunately I have not been able to consult this paper at first hand, and so have had to rely upon the partial résumé furnished by Hough ("Biological Bulletin," Vol. I. (1899), pp. 19–20).

‡ "Beitrag zur Systematik der Musciden": "Berliner Entomologische Zeitschrift," Bd. xxxviii. (1893), p. 299.

§ *Loc. cit.*, pp. 297, 298.

‖ *Loc. cit.* p. 299.

and *Echinomyia*, since the former have an exposed, the latter a protected metathoracic stigma. In venation, however, *Glossina* is more specialised than the Anthomyinæ that in Girschner's arrangement are grouped with it, since it is provided with a "*Spitzenquerader*" (bent-up terminal portion of the fourth vein), which, joining the margin of the wing before the apex, leaves the latter entirely membranous; this condition is in Girschner's opinion a protection to the veins in most intimate connection with the respiratory system.* In respect of venation, too, as also in having the membrane of the wings *rilled* instead of smooth,† *Glossina* is more specialised than its immediate allies, *Stomoxys*, *Hæmatobia* and *Lyperosia*, in which the third and fourth veins both reach the apex of the wing, the fourth vein being only slightly bent up at its extreme tip, well beyond the posterior transverse vein, while the membrane of the wings is not rilled.

It is stated by Girschner‡ that the chætotaxy of the *sternopleuræ* in his family "Anthomyidæ" (which includes the groups "Cœnosiinæ" and "Muscinæ") differs very much, and is even variable in the species of the same genus, so that it is of only subordinate value for systematic purposes. The author in question goes on to say :—"It is, however, characteristic of all Anthomyids that, in the cases in which the sternopleura shows only three macrochætæ, the order of arrangement is invariably 1:2, *i.e.* the larger number of bristles always occurs on the hind border of the sternopleura." As will be seen from Fig. 11, p. 69, this is precisely what we find in the case of *Glossina*. In Girschner's family "Tachinidæ," however, when three sternopleural bristles are present, the characteristic arrangement is always 2:1, or the three bristles stand in a row, as in *Sarcophaga* and *Brachycoma*.§

In conclusion, since Girschner has introduced an element of confusion by employing old family names in new senses, it is sufficient for present purposes to remember that, in terms of the simplest taxonomy, the genus *Glossina* belongs to the sub-family

* Cp. Girschner, *loc. cit.* pp. 299-300.

† *Cf.* Hough, "Biological Bulletin," Vol. I. (1899), p. 20, note 1 :—"These rills are very fine grooves in the surface of the wing which run in a sort of radiate manner toward the border. They are very numerous. A rilled wing denotes a higher stage of development, a more recent form, than an unrilled wing."

‡ *Loc. cit.* p. 302.

§ Girschner, *loc. cit.* p. 303.

Muscinæ, of the family Muscidæ, and that its nearest existing allies are found in the genera *Stomoxys*, *Hæmatobia*, *Lyperosia* and *Beccarimyia;* but that it is a highly specialised form, exhibiting several unique structural features, in addition to a very peculiar mode of reproduction. In some respects *Glossina* approaches most nearly to *Lyperosia*, while as regards other structural characters it comes nearer to *Stomoxys*. If, however, we rely upon the character and mutual relations of the proboscis and palpi, the Tsetse-flies are certainly more closely allied to *Lyperosia* than to any other genus at present known.

CHAPTER IV.

SYSTEMATIC DESCRIPTION OF THE GENUS GLOSSINA AND ITS SPECIES, WITH NOTES ON THEIR DISTRIBUTION AND HABITS.

Genus **GLOSSINA.**

Glossina, Wiedemann, Aussereuropäische zweiflügelige Insekten, Zweiter Theil, pp. 253, 254 (1830). **Nemorhina,** Robineau-Desvoidy, Essai sur les Myodaires (Mémoires présentés . . . à l'Académie Royale des Sciences de l'Institut de France . . . Sciences Mathématiques et Physiques. Tome Deuxième), pp. 389, 390 (1830).

Narrow-bodied, elongate, dark greyish-brown or yellowish-brown dull-coloured flies, ranging in size from $7\frac{1}{3}$ *millim.** ($3\frac{1}{2}$ *lin.*) *in the case of a small specimen of* Glossina morsitans, *Westw., to* 12 *millim.** ($5\frac{2}{3}$ *lin.*) *in that of a large female of* Gl. fusca, *Walk.; recognisable when alive and at rest by the wings being closed flat one over the other above the abdomen* (*beyond which they project considerably*), *instead of divaricate* (*as in the case of* Stomoxys) *or tectiform* (*as in* Hæmatopota†), *and by the proboscis* (i.e., *proboscis ensheathed in the palpi*), *which in length is equal to*

* Length measured from the face to the end of the abdomen, excluding the proboscis and wings.

† In the case of the genus *Hæmatopota* (family *Tabanidæ*), the species of which (in England often known as "clegs") are greedy blood-suckers, and, though readily distinguishable by the prominent antennæ, are not unlike those of *Glossina* in shape, size, and general colouration, the wings, when the insect is at rest, are somewhat tectiform (*i.e.* their anal angles meet together like the roof of a house), as well as slightly divaricate. Dr. Kertész's Catalogue of Tabanidæ ("Catalogus Tabanidarum Orbis Terrarum Universi: conscripsit Dr. Colomannus Kertész. Budapestini, 1900") contains the names of some twenty species of *Hæmatopota* described from various parts of Africa, and from specimens brought home by collectors it is clear that *Hæmatopota* is sometimes mistaken for *Glossina* when alive (*Cf.* Fig. 4, p. 6).

the thorax without the scutellum, projecting horizontally in front of the head; palpi, as seen in the natural position, extending slightly beyond the proboscis, their inner sides grooved so as to form a sheath for the latter, to which in life they are applied so closely as entirely to conceal it; base of proboscis suddenly expanded beneath into a large onion-shaped bulb.*

Head rather narrower than the thorax; eyes separate in both sexes, though the front in the ♀ is distinctly narrower than in the ♀ of *Stomoxys;* width of the front at the vertex in the ♂ ranging from one-third to rather more than one-half of that of the eye at its widest part, and in the ♀ from one-half to rather more than one-half of the width of the eye; vertex slightly depressed below the level of the eyes; facial pit deep, undivided by a septum, extending to the oral margin, which is up-turned and prominent; curved suture (*Bogennaht* of Brauer and von Bergenstamm) ending in a pit above the lower margin of the eye, the pit on each side being prolonged into a shallow depression (*transverse impression* of Hough) separating the face from the jowls †; the latter narrow in front, broad and rounded posteriorly, crossed by a line of black bristles which passes on to the occipital surface of the head, and is continued as the series of small bristles marking off the posterior orbits; jowls thickly clothed with fine hair behind the line of black bristles just mentioned, in front, like the face, bare; vibrissal ridges sharp and narrow, not broadening out below as in *Stomoxys*, *Hæmatobia*, and other genera of Muscinæ, ciliated to the level of half the length of the third joint of the antennæ, or higher; vibrissæ small, fine, no elongated or conspicuous vibrissa even on the vibrissal angle, which is widely separated from the oral margin. Underside of the roof of the buccal cavity with two large dark brown strongly chitinised patches, very conspicuous when the head is viewed from below in every species except *Gl. fusca* and *Gl. longipennis*. Eyes bare, in both sexes the facets in front

* The length of the visible portion of the palpi, *i.e.* the portion projecting beyond the buccal cavity, in *Glossina morsitans*, Westw., is just under 3 millim. (1⅛ lin.); the length of the entire proboscis, measured from the base of the bulb, is 3½ millim. (1⅜ lin.).

† I follow Mr. G. H. Verrall ("British Flies, Syrphidæ, etc.," 1901) in using the term *jowl* for the part of the head beneath the eyes, which in former papers I have called the cheek (*Backe*, of German authors), separated from the *face* (German, *Wange*) by the curved suture or its prolongation. In 1898 Hough ("Proc. Acad. Nat. Sc., Philadelphia," 1898, p. 168) proposed the terms *gena* and *bucca* for *Wange* and *Backe* respectively.

towards the inner margin conspicuously larger than those behind. First two joints of the antennæ small, the third long, nearly reaching the oral margin, concave in front, the tip being

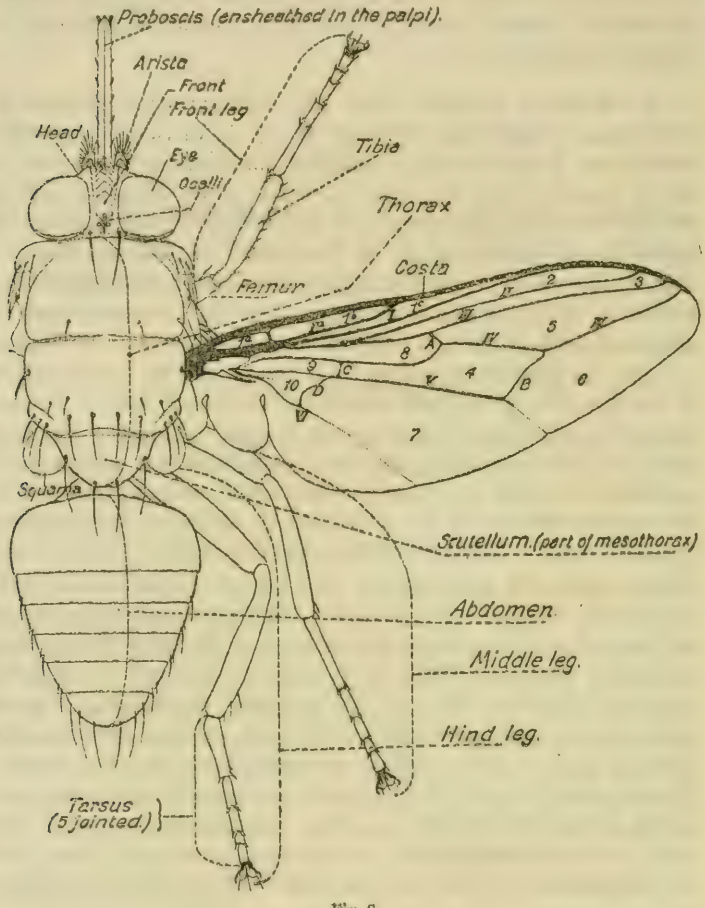

Fig. 8.

Diagram showing nomenclature of external characters of *Glossina*, used in description.

VEINS AND CELLS IN THE WING.

Longitudinal Veins.

I^a. Auxiliary vein.
I. First longitudinal vein.
II. Second ,, ,,
III. Third ,, ,,
IV. Fourth ,, ,,
V. Fifth ,, ,,
VI. Sixth ,, ,,

Transverse Veins.

A. Anterior transverse vein.
B. Posterior ,, ,,
C. Anterior basal ,, ,,
D. Posterior ,, ,, ,,

Cells.

1^a, 1^b, 1^c, First, second, and third costal cells.
2. Marginal cell.
3. Sub-marginal cell.
4, Discal cell.
5, 6, 7, First, second, and third posterior cells.
8. Anterior basal cell.
9. Posterior ,, ,,
10. Anal cell.

produced into a prominent forwardly-directed angle. On the inside of the third joint of the antenna near the base a minute though well-marked pore can usually be distinguished, constituting the orifice of a sense-organ (see Fig. 9).* Arista distinctly two-

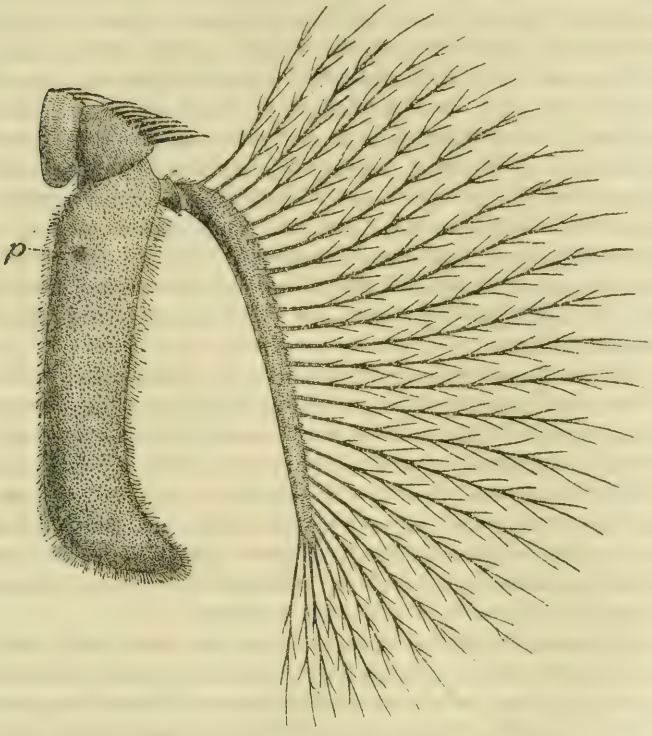

Fig. 9.
Left antenna of *Glossina pallidipes*, Austen, ♂, from the inner side (× 60); *p*, aperture of sense-organ on third joint.

jointed, though basal joint very small; second joint remarkably broad throughout its length, flat, tapering somewhat to the tip, but far from being reduced distally to the proportions of a fine hair, as in the case of the arista of *Stomoxys;* feathered on the upper side alone (including the tip) with some twenty-two fine, curving,

* Dr. Stuhlmann [174], writing of *Gl. fusca*, Walk., calls this an "auditory" organ. If the antenna be mounted in glycerine and examined under a low power, the sense-organ has the appearance of an oval sac.

branched hairs (see Figure 9).* Proboscis projecting as already described and, with the palpi, curving slightly downwards; reddish-brown below, glistening yellowish-white above nearly to the tip, which is marked off by a slight constriction and exhibits beneath a tiny but conspicuous black spot; the bulbous base of the proboscis is enwrapped posteriorly with a fold of skin forming the hind wall of the buccal cavity. Palpi rod-like, of the same width throughout, neither swollen nor tapering towards the tips, clothed with short black hairs and minute bristles, a row of some eight to thirteen tiny erect black bristles running along the upper margin, the individual bristles separated by something like regular intervals, and a similar row running along the outside on the basal two-thirds of the palpus; two somewhat longer and stouter bristles † directed downwards and forwards on the under and outer side immediately before the tip. (For the bristles of the head see below under "Chætotaxy.—Cephalic Bristles.")

Thorax quadrate, flattened or only very slightly arched above, to the naked eye appearing bare, but in reality sparsely clothed with minute black hairs; the macrochætæ likewise few in number, arranged as described below under "Chætotaxy." Transverse suture well-marked, forming a groove. Scutellum flattened, with a pale impressed median line, and a darker patch on each side. Markings of the thorax very inconspicuous, and, if distinguishable at all from the ground colour, taking the shape of grey or brown blotches, streaks, or spots.

Abdomen also flattened, tapering to the apex, thinly clothed with minute and exceedingly short, appressed black hairs, which on the basal angles of the second segment become longer and erect, and on the hind margins of the following segments, from the third to the fifth, take the shape of fine black bristle-like hairs, especially on the apical angles, where they are longest and stoutest; hind margin of the sixth segment, and also that of the seventh in the female, with a complete row of longer bristle-like hairs; seventh segment in the male with an especially conspicuous transverse row of black bristle-like hairs or fine bristles on each side of the median line beyond the middle. *The male hypopygium*

* The number of these hairs is usually about twenty-two or twenty-three, but sometimes there are not more than eighteen, while in other cases there may be as many as twenty-eight; the numbers on each arista may even be unequal in the same specimen.

† In dried specimens these are often missing—one at least is frequently indistinguishable.

highly characteristic in shape (see Figures 12 and 13, p. 94), *oval and tumid*, its longer axis lying in the antero-posterior direction, *with a vulviform median groove* (the anus) *running from the anterior margin to beyond the middle.* Ventral plate of the sixth segment in the male, immediately in front of the hypopygium, bearing a patch of close-set erect minute black hairs no each side of the median line : ventral plates of the remaining segments except the first in the male, and of all the segments except the first in the female, membranous.

Legs simple, rather long, claws longer and pulvilli somewhat larger in the male than in the female. Front femora with a row of bristle-like hairs above and below, and (except in the case of *Gl. morsitans* *) on the posterior surface with a median row of minute black spines. Middle and posterior femora with a row of bristle-like hairs on the basal half of the anterior surface, near the upper margin, and with a shorter row of similar hairs, or short bristles as the case may be, at the base beneath. Middle femora with a solitary bristle, usually conspicuous in the larger species, on the upper side near the tip. Tibiæ with a well-marked ridge, edged with a row of closely-set minute black spines, running down the outer surface, so that they, especially the front and hind pair, usually have the appearance of being somewhat flattened from side to side ; the middle tibiæ have a second row of still more minute spines in advance of that just mentioned, the space between, owing to the presence of the ridge, having the appearance of being excavated. Tibiæ also with a row of short fine hairs or bristle-like hairs running down the outer side, and sometimes with one or two short bristles close to the apex on that side, otherwise, with the exception of the usual apical spines, entirely devoid of isolated bristles or bristle-like hairs. On the three basal joints of the front and middle tarsi three rows of minute black spines similar to those on the tibiæ ; on the basal joints of the hind tarsi they are less distinct, but apparently two rows are present.

Wings with an *absolutely unique venation* (see Figure 8), which, apart from all other characters, will at once serve to distinguish a specimen of the genus. The most striking peculiarity is the course of the *fourth longitudinal vein.* The anterior basal transverse vein, at the base of the discal cell, is very short, and the portion of the fourth longitudinal vein before the anterior (small)

* In the case of *Gl. longipennis*, too, the row appears to be broken up into a double line and is consequently barely distinguishable.

transverse vein is bent downwards in such a way as greatly to narrow the basal half of the discal cell, the width of the distal portion of the anterior basal cell being correspondingly increased; the fourth vein bends abruptly upwards to the point of contact with the anterior transverse vein, where it forms with itself what is practically a right angle; from this point it again runs obliquely downwards, and is once more bent upwards at the exact point of contact with the posterior transverse vein, ultimately reaching the margin of the wing some distance before the apex. The first posterior cell is open, but its distal portion is narrow and much drawn out. The third longitudinal vein is very close to the second, and shows a marked approximation to the costa, the sub-marginal cell being correspondingly narrow; the third costal cell is considerably elongated; the second, third, and fourth longitudinal veins all turn upwards at the tips, and *the anterior transverse vein is very oblique*; the sixth longitudinal vein becomes obsolete soon after the anal cell, though in clear, unchitinised form it can still be traced nearly to the margin of the wing. Posterior basal transverse vein, closing the anal cell, angulate in the middle, so that the distal angles of the cell are acute. Posterior transverse vein slightly curved, bent up somewhat abruptly to meet the fourth longitudinal. Wings of an uniformly brownish hue, varying in intensity in the different species, but apparently palest in *Gl. morsitans*; membrane of the wing rilled.*

[*Resemblance in venation between* Glossina *and* Hypoderma.—While there are many noticeable differences, the venation of the wing of *Glossina* resembles that of the Œstrid *Hypoderma* (Warble-flies) more closely than that of any other genus, especially as regards the shape of the first posterior cell. In both cases the fourth vein is bent up to form what German authors call a "*Spitzenquerader*" precisely at its junction with the posterior transverse vein. But in the wing of *Hypoderma* the anterior transverse vein is not oblique, and the fourth longitudinal vein before reaching it is not bent down in the manner so characteristic

* *Cf.* Garry de N. Hough, M.D., "Some Muscinæ of North America," "Biological Bulletin," Vol. I. (1899), p. 20, note 1:—"These rills are very fine grooves in the surface of the wing, which run in a sort of radiate manner towards the border. They are very numerous. A rilled wing denotes a higher stage of development, a more recent form, than an unrilled wing."

of *Glossina;* besides this, the first and second longitudinal veins pursue a different course, and the shape of the posterior basal and of the anal cell is very different. The shape of the wing itself is also different, and the wing is much smaller in proportion in *Hypoderma* than in *Glossina*.]

Chætotaxy of *Glossina*.

Cephalic Bristles.—One pair of *vertical* bristles of large size (the largest and most conspicuous bristles on the head); on the occipital region no trace of the pair of bristles termed by Hough (Proc. Acad. Nat. Sc. Philad. 1898, p. 166) the *occipito-central; greater ocellar* bristles (ocellar pair of Osten Sacken) small;

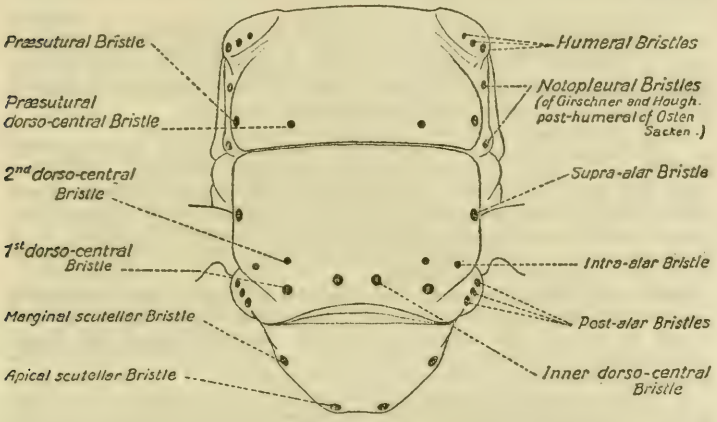

Fig. 10.
Diagram of thoracic chætotaxy of *Glossina*, dorsal aspect. (× 10.)

post-vertical pair not differentiated in size from the remainder of the lesser ocellar bristles; *frontal* bristles largest below (trans-frontal group of Hough, *loc. cit.*); *orbital* bristles absent in both sexes; *vibrissal angle* (separated by a well-marked and rather wide interval from the oral margin) without a large and conspicuous vibrissa; *vibrissal ridges* ciliated to a point on a level with or rather above the middle of the third joint of the antenna.

Thoracic bristles.—The general arrangement, as can be seen from the accompanying diagrams, is, *on each side*, as follows:—

Dorsal aspect (*Fig.* 10).—*Humeral*, from 1 to 3 (sometimes apparently 4), the lowest bristle the largest. *Post-humeral*

(intra-humeral of Osten Sacken) absent. *Notopleural* (of Girschner and Hough, post-humeral of Osten Sacken), 2. *Præsutural*, 1.* *Supra-alar*, 1. *Intra-alar*, 1, situated just in front of the post-alar callus, on a level with the second dorso-central.† *Post-alar*, 3, the foremost somewhat smaller than the other two, and placed directly above the alar frenum.‡ *Dorso-central*, 3, two near together, close to the hind margin of the dorsum, and one immediately in front of the suture; the latter bristle may be termed the *præsutural dorso-central*.§ *Inner dorso-central*, ‖ 1, near the hind margin of the thorax. *Scutellar*, 2, one marginal (near the basal angle), the other apical; in certain specimens of *Glossina fusca*, Walk., and *Gl. longipennis*, Corti, there is a second marginal bristle in front of the ordinary one, and also, in

* Often small and difficult to distinguish in *Gl. palpalis*.

† I follow Hough (*loc. cit.* p. 180) in numbering the dorso-centrals from rear to front, except that, for reasons explained in the note below, I term the comparatively large dorso-central bristle immediately in front of the transverse suture the *præsutural dorso-central*.

‡ *Cf.* Osten Sacken, Trans. Ent. Soc. Lond. 1884, p. 504.

§ In certain cases (*e.g.* individual specimens of *Gl. morsitans* and *Gl. longipalpis*) there are one or more small additional bristles (little larger than the small bristle-like hairs clothing the general surface of the dorsum, but nevertheless recognisable as bristles belonging to the dorso-central series) between the second dorso-central and the suture. It is therefore obviously impossible to give the dorso-central bristle in front of the suture a numerical designation.

N.B.—In Fig. 10 the extra dorso-central bristles, as well as certain others which sometimes occur, are not shown, the object being to represent so far as possible the normal chætotactic arrangement in the genus. Aberrations in chætotaxy noticeable in the material available for examination will be referred to under the individual species.

‖ *Cf.* Mik, "Ueber Acrostichalbörstchen (*setulæ acrostichales*)": Wien. Ent. Z. xix. Jahrg. 1900, pp. 151–152.—As pointed out by Mik (*loc. cit.* p. 152), recent writers on Muscidæ, such as Girschner and Stein (as also Hough), following an original slip on the part of Osten Sacken (*cf.* Trans. Ent. Soc. Lond. 1884, p. 509), have misapplied the term *acrostichal* in using it for the *inner dorso-central* series of bristles. The small acrostichal bristles, however, cannot be interpreted as inner dorso-central bristles. Mik adds: "The dorso-central bristles are always symmetrically (bilaterally) arranged macrochætæ, whereas the little acrostichal bristles (*Acrostichalbörstchen*) belong to the ordinary original covering of the dorsum of the thorax and occur by no means seldom in a single row along the sagittal line, or may form even more than two longitudinal rows. It may also happen that little acrostichal bristles occur even when the two rows of the inner dorso-central bristles are present. Whoever, for instance, examines a Dolichopodid provided with little acrostichal bristles will at once recognise that these little bristles have nothing to do with the macrochætæ, but that they belong to the same category of covering (*Bekleidung*) as the tiny bristles that occur on the anterior portion of the mesothorax, especially behind the humeral calli."

I am indebted to Mr. J. E. Collin for directing my attention to Mik's note, which otherwise I should have overlooked, as it is concealed among the last instalment of the lamented author's "Dipterologische Miscellen."

some specimens of *Gl. fusca*, an extra bristle between the ordinary marginal and the apical.

Out of the material examined certain specimens, belonging to *Gl. morsitans*, Westw., *Gl. pallidipes*, Austen, and *Gl. palpalis*, R.-Desv., show an additional small bristle in advance and a little to the outside of the intra-alar: whether this bristle should be regarded as belonging to the intra-alar or to the supra-alar series I am unable to determine. In *Gl. longipennis*, *Gl. fusca*, and (less clearly) in *Gl. pallidipes* an incomplete circlet of short stoutish bristles (not shown in the figure) can be seen on the anterior margin of the dorsum of the thorax between the

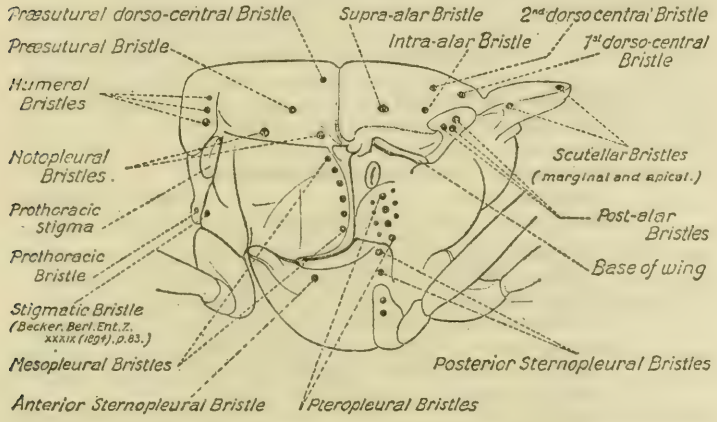

Fig. 11.

Diagram of thoracic chætotaxy of *Glossina*, pleural aspect (× 10).

N.B. There are no bristles on the hypopleura (the region above the last two pairs of coxæ) in *Glossina*, though Osten Sacken writes (Trans. Ent. Soc. Lond., 1884, p. 513):—"Most of the Calyptrata, except the Anthomyidæ, have a tuft or row of bristles on the hypopleura, a region which is destitute of them in the other families of Diptera."—See also Girschner, "Beitrag zur Systematik der Musciden:" Berliner Entomologische Zeitschrift, Bd. xxxviii. (1893), pp. 297–298. According to Girschner's arrangement, *Glossina* belongs to the group Muscinæ of his "Family Anthomyidæ."

humeral callosities. These bristles are frequently difficult to distinguish owing to the shadow between the head and the thorax. There are usually three bristles on each side, close to the humeral callosity, while a bristle on each side of the median line would appear to belong to the inner dorso-central series.

The relative size of the various bristles enumerated above is roughly indicated in the diagrams by the size of the dots. Generally speaking the largest bristles are the lowest humeral, the notopleural, supra-alar, post-alar, the bristles of the transverse

row formed by the first and inner dorso-centrals, and the marginal and apical scutellar bristles.

Pleural aspect (Fig. 11).—*Prothoracic*, 1. *Stigmatic* (*cf.* Becker, Berl. Ent. Z. xxxix (1894), p. 83), 1. *Mesopleural*, a vertical row of about 6 along the posterior edge, with smaller bristles in between. *Pteropleural*,* a vertical row of usually 3 (stout and conspicuous only in *Gl. longipennis*, Corti, and *Gl. fusca*, Walk., more numerous in the latter than in the former), with smaller bristles on either side. *Sternopleural*, 3,—1 anterior, and 2 posterior: below, a conspicuous row of bristles in front of the middle coxæ. *Hypopleural*, none.

SYNOPSIS OF SPECIES.

1. Hind tarsi entirely dark 2
   Hind tarsi not entirely dark: last two joints alone dark, remainder pale 3
2. Third joint of antennae dusky-brown to cinereous-black ..... *palpalis*, Rob.-Desv.
   Third joint of antennae pale (orange-buff) ... *pallicera*, Bigot.
3. Large species: length at least 10½ millim. (5 lin.), wing-expanse (measured from tip to tip, when wings are set at right angles to body) at least 25 millim. (11⅔ lin.) 6
   Smaller species: length not exceeding 10½ millim. (5 lin.), often considerably less; wing-expanse not exceeding 22½ millim.) (10½ lin.) 4
4. Last two joints of front and middle tarsi with sharply defined dark brown or black tips... 5
   Last two joints of front and middle tarsi without sharply defined dark brown or black tips—front and middle tarsi entirely yellow, or last two joints of former faintly tipped with pale brown ..... *pallidipes*, sp. nov.
5. Generally distinctly larger; head wider; front darker and narrower in both sexes, sides parallel in ♂; abdominal bands deeper, leaving hind margins of segments only narrowly pale; hypopygium in ♂ smaller, darker, and more hairy; tip of ♂ abdomen more thickly clothed laterally with short black hair, bristles on 6th segment finer and less prominent ..... *longipalpis*, Wied.

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* Pteropleural bristles seem to be entirely wanting in *Stomoxys*, *Hæmatobia*, and other genera of Muscinæ.

Usually smaller; head narrower; front paler and wider; eyes in ♂ as well as in ♀ distinctly converging towards vertex; abdominal bands less deep, pale hind margins of segments therefore deeper; hypopygium in ♂ larger, paler, somewhat more oval in outline, and clothed with fewer fine hairs; tip of ♂ abdomen less hairy laterally; bristles on 6th segment in ♂ stouter and more conspicuous ..... *morsitans*, Westw.

6. Dorsum of thorax with four sharply defined small dark brown oval spots, arranged in a parallelogram, two in front of and two behind transverse suture; bulb at base of proboscis brown at the tip ..... *longipennis*, Corti.

Dorsum of thorax without such spots, though with more or less distinct longitudinal stripes; bulb at base of proboscis not brown at the tip ..... *fusca*, Walk.

Glossina palpalis, Rob.-Desv.

(Plate I.)

Nemorhina palpalis, Robineau-Desvoidy, Essai sur les Myodaires (Mémoires Présentés par Divers Savans à l'Académie Royale des Sciences de l'Institut de France. Sciences Mathématiques et Physiques. Tome Deuxième), p. 390 (1830).

Stomoxys longipalpis ?, Walker (*nec* Wiedemann), List Dipt. Ins. in Coll. Brit. Mus., Pt. III., p. 682 (1849).

Glossina tachinoides, Westwood, Proc. Zool. Soc. Lond., Pt. XVIII., p. 267, Pl. XIX., fig. 2 (1850): Ann. Mag. Nat. Hist. Ser. 2 Vol. X., p. 147 (1852).

Glossina longipalpis, Walker (*nec* Wiedemann), Entomologist, VI., p. 328 (1873).

Glossina ventricosa, Bigot, Ann. Soc. Ent. France, 6e Série, T. 5, pp. 122, 123 (1885).

Glossina longipalpis, Bigot (*nec* Wiedemann), *ibid.* p. 122.

Glossina tabanifornis, Bigot (*nec* Westwood), *ibid.* p. 123.

Glossina longipalpis, Austen (*nec* Wiedemann), Report of the Proceedings of the Expedition for the Study of the Causes of Malaria, etc., p. 18 (1899).

♂, ♀.—Length* 8 to 9½ millim. (3¾ to 4½ lin.); length of wing 8 to 9¼ millim. (3¾ to 4⅓ lin.); width of head 2½ to 2¾ millim. (1¼ to 1⅓ lin.).

* The length given is in all cases exclusive of the proboscis and palpi, and is measured from the epistoma to the tip of the abdomen.

Dark brown; thorax usually paler, with dark brown markings on a grayish ground; abdomen generally with at least an indication of a pale longitudinal median stripe, with pale lateral triangular markings, and usually the hind margins of the segments narrowly pale. Legs (except the hind tarsi and last two joints of the front and middle pairs) sometimes entirely buff-coloured (var. tachinoides, Westw.); *usually the femora for the most part or entirely dark brown, in well preserved specimens clothed with grayish dust, and the tibiæ yellowish.*

Head:—face yellowish, clothed below with grayish dust; posterior surface of head entirely cinereous; *frontal stripe* varying from ochraceous to dark chestnut; frontal margins grayish, seen from the side with a dark brown elongated area below; ocellar triangle cinereous, enclosing the dark-brown ocellar spot, which is joined posteriorly to a sharply defined dark-brown band, uniting the vertical bristles and very conspicuous except in the darkest specimens. *Antennæ*: 2nd joint more or less yellow at the apex in front, 3rd joint narrowly yellow at the extreme base on the outer side, otherwise entirely dark, with grayish shimmer; arista yellowish, dark brown on the under side. *Palpi* cinereous, blackish on upper side. Bulb at base of proboscis dark brown. *Thorax* in the most clearly marked specimens bluish-gray or cinereous, with brown markings as shown in Plate I. These markings when fully visible are as follows: a narrow stripe on each side of the median line, interrupted before reaching the transverse suture and again before reaching the hind margin; the section of each stripe behind the suture is expanded posteriorly, and the terminal portion of the stripes immediately in front of the hind margin takes the shape of a pair of more or less confluent ill-defined spots, sometimes confluent with the stripes in front; next to the two admedian stripes on each side on the suture itself a more or less sharply defined oval spot; on the outside of this a longitudinal stripe, more or less interrupted and sometimes obsolete in the middle, but in front curving round outwards behind the humeral callus and then running backwards along the lateral margin of the dorsum nearly to the post-alar callus; in the area thus enclosed a broad ill-defined patch in front of and behind the suture, while the lateral stripe itself sends off two prolongations, which run inwards for a certain distance on each side of the suture. Humeral callus with a spot on its upper portion, confluent with the curved stripe behind it; a more or less ill-

defined spot on the post-alar callus also. Pleuræ cinereous, a more or less distinct brown patch in the centre of the mesopleura. *Scutellum* cinereous at the base, yellowish towards the tip and along the margin, the usual brown patch on each side of the median line more or less conspicuous.

In dark specimens the markings on the dorsum of the thorax become confluent to such an extent that the dorsum appears almost wholly brown, the bluish-gray or cinereous ground colour being scarcely visible except in front on either side of the confluent ad-median stripes.

Abdomen dark brown; first segment and a median triangular area on the second (its base resting on the front and its apex on the hind margin of the second segment) buff-coloured or cinereous, the pale triangle continued backwards as a narrow, more or less well-defined median stripe, usually reaching at least as far as the hind margin of the fifth segment; lateral margins of the segments from the second onwards cinereous or buff-coloured, expanded on the apical angles into triangular markings; extreme hind margins of the segments from the second to the sixth usually narrowly pale or cinereous; seventh segment, as also the hypopygium in the ♂, entirely cinereous.

In a very dark ♂ from Asaba, R. Niger (*Dr. W. H. Crosse*), the pale triangle on the second segment is but faintly indicated, and the remainder of the upper surface (with the exception of the cinereous lateral triangles which, since the lateral margins are turned down, cannot be seen from above) is wholly dark brown, the pale median stripe and hind margins to the segments being wanting.

Legs.—Coxæ yellowish cinereous; femora cinereous to cinereous-brown (the middle and hind femora on the outside towards the tips sometimes darker than elsewhere), the knees, extreme base of front femora, basal half of the middle femora on the inner side, more or less of the basal half of the hind femora on both inner and outer sides, and usually an ill-defined area at the tips of the hind femora also, yellow; trochanters likewise yellow; front and middle tibiæ, and first three joints of front and middle tarsi yellow; hind tibiæ yellow to yellowish-brown; hind tarsi entirely black above; last two joints of front and middle tarsi blackish-brown, except their bases, which are more or less distinctly yellow.

The proportion of yellow on the femora is variable, and they are sometimes more yellow than cinereous; on the other hand,

the very dark ♂ from Asaba, already alluded to, has the femora, with the exception of the knees at the extreme tips and the extreme base of the hind pair on the inside, entirely dark cinereous-brown.

Wings uniformly brownish. Squamæ white, border of the antisquama darker, fringed with short darker hairs. *Halteres* yellowish white.

Var. *tachinoides*, Westw.—*Legs, except hind tarsi and last two joints of front and middle pairs, wholly pale yellow; median stripe and the other pale markings on the abdomen very conspicuous.*

Bulb at base of proboscis ochraceous instead of dark brown, but with a dark brown patch on each side towards the tip. *Pleuræ and humeral calli* more or less ochraceous-buff; the same colour may also appear on the dorsum of the thorax between the curved stripes and the enclosed dark patches.

Abdomen.—In two ♀ ♀ from the Gambia (*Dr. Dutton*) the median stripe is unusually broad and well-marked, and extends outwards along the front and hind margin of each segment from the third to the sixth; the lateral triangles are also exceptionally conspicuous, more clearly buff-coloured than is usually the case in the typical form, and are prolonged conspicuously on to the upper side along the hind margins of the segments, the pale hind margins themselves being broader than in the typical form and well-marked.*

The var. *tachinoides*, therefore, clearly shows the connection between the typical *Gl. palpalis*, with uniformly dark-brown abdomen, only relieved by a pale median stripe and more or less conspicuous lateral triangles, and *Gl. morsitans* or *Gl. longipalpis*; for the abdomen of var. *tachinoides*, at any rate as represented by the two ♀ ♀ referred to, might well be described as cinereous-buff, with dark brown interrupted transverse bands.

Legs, with the exception of the hind tarsi and last two joints of the front and middle tarsi, entirely pale yellow, though there is sometimes a small dark patch on the outside of the middle and hind femora towards the tip.

* In addition to the two ♀ ♀ from the Gambia, the Museum collection includes four other specimens (two ♂ ♂ and two ♀ ♀) which must be regarded as belonging to the var. *tachinoides*. According to their labels, they are from the "Zambesi" (*Dr. Kirk*). All have the legs pale, with the exception of the hind tarsi, which are wholly dark, and the last two joints of the front and middle pairs, which are partially infuscated, but the median abdominal stripe and the pale hind margins to the abdominal segments are not especially conspicuous except in the case of one female.

Distribution of *Gl. palpalis*, Rob.-Desv.

The present species, which is the *Glossina longipalpis* of authors (*nec* Wiedemann), has a wide range in West Africa, and, as is shown by the localities of the specimens before me, in its distribution from north to south extends at least from the Gambia (var. *tachinoides*) to the Congo, though from our knowledge of the extremely local occurrence of *Glossina morsitans* in South Africa, as indicated by the familiar term "fly-belt," it is not at all likely that *Gl. palpalis* will be found to occur everywhere on the West Coast. As to the range of the species inland all that can be stated at present is that var. *tachinoides* was found by Dr. (afterwards Sir) John Kirk on the Zambesi—the precise locality is unfortunately unknown. *Gl. palpalis*, however, is not the only species found in West Africa, since, as will be shown later, *Gl. pallicera*, Big., *Gl. fusca*, Walk., *Gl. longipalpis*, Wied., and *Gl. morsitans*, Westw., also occur there.

The above description has been drawn up from an examination of forty-nine (29 ♂♂, 20 ♀♀) specimens from various localities, as indicated by the following list* :—

4 ♂♂, mouth of Kissy River, near Free Town, Sierra Leone, 16. viii. 1899, "among mangroves, on boats" (*E. E. Austen*); 2 ♂♂, Wilberforce, near Free Town, Sierra Leone, 10. ix. 1899, "settling on stones in hillside stream at garrison watering-place" (*E. E. Austen*); 1 ♂, "Gold Coast" (*A. Swanzy*); 1 ♀, "Gold Coast" (*Capts. Burton and Cameron*); 5 ♂♂, 3 ♀♀, Assinie, Ivory Coast (*Ch. Alluaud*) [V.]; 5 ♂♂, 6 ♀♀, Togo (*Dr. Schilling*), [Royal Zoological Museum, Berlin]; 1 ♂, Benin (*A. Millson*); 1 ♀, Degema, Nigeria, 8. viii. 1900 (*Dr. A. H. Hanley*); 1 ♂, 1 ♀, Asaba, R. Niger (*Dr. W. H. Crosse*); 1 ♂, Fernand Vaz River, French Congo (*Du Chaillu*); 3 ♂♂, Congo† (presented by Miss E. M. Bowdler Sharpe); 1 ♀, Congo (the specimen referred to by Walker, List Dipt. *loc. cit.*, as *Stomoxys longipalpis*); 1 ♂, Congo [O.—Ex Coll. Saunders]; 2 ♂♂, 1 ♀, locality unknown [V.];

* Throughout the present chapter, specimens not in the collection of the British Museum are distinguished as follows: those belonging to the Oxford Museum by the letter [O.]; those in the collection of Mr. G. H. Verrall (formerly in that of the late M. Bigot) by the letter [V.]; and those in the collection of Mr. L. R. Crawshay by the letter [C.] Wherever possible the name of the Collector is given in italics, thus (*F. J. Jackson*).

† *Glossina palpalis* was described from a specimen from the Congo; Robineau-Desvoidy writes (*loc. cit.*): "Cette curieuse espèce, originaire du Congo, fait partie de la collection du comte Dejean."

2 ♀ ♀, locality unknown [V.—The types of *Gl. ventricosa*, Big.].

Var. *tachinoides*, Westw.—1 ♂, "West Africa" [O.—The type of *Gl. tachinoides*, Westw.]; 2 ♀ ♀, R. Gambia, between Nov. 1901 and Jan. 1902 (*Dr. J. E. Dutton*); 2 ♂ ♂, 2 ♀ ♀, "Zambesi" (*Dr.* (afterwards *Sir*) *John Kirk*).

Habits, etc.

Glossina palpalis was quite common in the vicinity of Free Town, Sierra Leone, during the months of August and September, 1899. It always seems to occur along the beds of streams, where it is fond of sitting on stones projecting from the water; it also abounds in mangrove thickets fringing the mouths of streams, close to the sea-shore. On one occasion I found it among bushes on the hillside below Wilberforce, settling on stones in a small stream barely a yard in width. The fly was also met with on the way to Regent, where the road crosses a little brook, and it probably occurs along all the streams in the neighbourhood of Free Town. It bites and sucks human blood freely, and the writer and two companions were once severely bitten by it while resting undressed on the sea-shore after bathing, close to a mangrove thicket at the mouth of a stream. The fly is remarkably active and exceedingly difficult to catch, but persistently returns to the same spot. English-speaking natives, when questioned, call it a "mangrove-fly,"—a name that, in West Africa, is also indiscriminately applied to various species of the blood-sucking Tabanidæ (Horse-flies).

As to the var. *tachinoides*, Dr. J. Everett Dutton, of the Liverpool School of Tropical Medicine, in a letter to Mr. F. V. Theobald, dated "Liverpool, Feb. 21st, 1902," writes as follows: "The small mangrove-fly is very prevalent up the river Gambia, where it comes on board the launches and bites viciously.—Now the case of *Trypanosoma* I found in Bathurst was in an Englishman who was master of the Government launch, living on board, and frequently bitten by this fly.—It is also interesting to note that the Colonial Surgeon informs me that the cases amongst the natives which he has seen, with similar symptoms to those in the white man, occurred in boatmen plying up and down the river."

Synonymy and Affinities.

Although Robineau-Desvoidy's description of *Nemorhina palpalis* is very brief, it is nevertheless recognisable; and though in this case I have not been able to examine the type, which there is only too much reason to fear is no longer in existence,* there need, I think, be no hesitation in applying the name *palpalis* to the present species. On the other hand, subsequent writers, relying on Wiedemann's description, and without having seen his type, may well be excused for considering it to be Wiedemann's *longipalpis*, especially since the type of the latter was stated to be from Sierra Leone. Judging merely from the description,† *Glossina longipalpis*, Wied., would appear to have been described from a specimen of the present species with pale legs, and well-marked pale median stripe and hind margins to the abdominal segments (*i.e.* var. *tachinoides*). As will be shown below, however, an examination of Wiedemann's type, which by the courtesy of the authorities of the Vienna Museum I have been enabled to make, proves conclusively that *Glossina longipalpis*, Wied., is a distinct species nearly allied to *Gl. morsitans*, Westw.

The type of *Glossina tachinoides*, Westw., is a mere fragment, but fortunately sufficient remains to establish its identity, and to show that it cannot be regarded as anything more than a variety of *palpalis*.

* As already stated in the previous note, according to the author *Nemorhina palpalis* was described from a specimen in the collection of Comte Dejean. In the hope of obtaining some information as to the type, and perhaps eventually the loan of it, I applied to the Muséum d'Histoire Naturelle, Paris, and received the following courteous reply (dated "17 avril 1902") from M. Joanny Martin, Assistant in charge of the collections of Diptera and Hemiptera in the Muséum:—"J'ai le regret de vous apprendre que nous ne possédons malheureusement pas la collection de Robineau-Desvoidy. Cet auteur avait légué ses collections au Musée d'Auxerre (Yonne). Depuis plusieurs années, il ne reste plus rien, absolument rien. Cependant comme ce Muscide appartenait à la collection Dejean il est bien possible que le lot de Diptères fut acheté par Bigot, qui à cette époque déjà étudiait les Diptères. Dans ce cas vous trouveriez le type qui vous préoccupe chez Mr. Verrall qui a acheté la collection Bigot. C'est la dernière chance qu'il vous reste pour retrouver ce précieux Diptère." Unfortunately there is no trace of Robineau-Desvoidy's type among the specimens from the Bigot Collection which Mr. Verrall has kindly lent me—unless indeed it is one of those without a label alluded to above, in which case there is now no means of identifying it.

† Wiedemann's figure (Auss. Zw. Ins. II., Pl. IX., fig. 10a) is worthless, but at the same time supports an erroneous conclusion by conveying the impression of a species with very dark abdomen and well-marked pale hind margins to the abdominal segments.

Glossina ventricosa, Bigot, proves on examination of the typical specimens, which, as already stated, are both females, to be nothing but *Gl. palpalis* with the abdomen enormously distended with coagulated blood. One of Sir John Kirk's specimens of *Gl. palpalis* from the Zambesi has the abdomen similarly distended, though to a smaller extent, and one of Dr. Dutton's examples of var. *tachinoides* from the Gambia also has the abdomen full of blood; a male *Glossina longipennis*, Corti, from Somaliland, belonging to the Museum collection, likewise has the abdomen swollen and distorted owing to contained blood. According to Bigot's statement (*loc. cit.* p. 121), he discovered the specimens described by him as *Gl. ventricosa* among a number of Diptera from Australia, which he had acquired a few years before the date of his paper (1885). In consequence of this Bigot gave the locality of his specimens as "Australie?" (*loc. cit.* p. 123), having previously (p. 121) stated that it was improbable that there had been any confusion as to their origin, and having drawn attention to the interest attaching thereto, since no representative of the genus had been met with outside Africa. Nevertheless there can be no doubt that confusion had taken place here. As is well known, the late M. Bigot was in the habit of removing the original labels from the specimens he acquired, and copying the data as to the locality on to the label bearing the specific name, which he pinned into the box containing them. Thus Bigot may well have removed the labels from these specimens, and then have put them down inadvertently among the Australian Diptera and forgotten them. Be this as it may, *Glossina ventricosa*, Bigot, is absolutely identical with *Gl. palpalis*, Rob.-Desv., and there is no evidence whatever that *Glossina* occurs outside Africa.*

* It is true that it had been previously suggested by Van der Wulp (Tijdschrift voor Entomologie, XXVII. (1884), p. 150), that the "Mouche charbonneuse" of New Caledonia was "probably a species of *Glossina*," but the suggestion is superfluous, since, given the presence of anthrax among cattle in the vicinity and an abraded surface of human skin, any carrion-haunting Muscid might quite possibly, as is the opinion of Macleay, produce the results (deaths from malignant pustule) supposed to be due to the bite of a particular fly in New Caledonia. See "Note on a Reputed Poisonous Fly of New Caledonia", by William Macleay, F.L.S., etc., Proc. Linn. Soc., New South Wales, Vol. VII. (1883), pp. 202–205. A fly caught in the act of biting by Mr. E. L. Layard, C.M.G., H.B.M. Consul, New Caledonia, and at first supposed to be the dreaded "Mouche charbonneuse," was determined by Macleay to be "a *Stomoxys*, an insect not uncommon in this country [Australia], and very probably introduced, as Mr. Layard suggests, into New Caledonia and the Isle of Pines from Australia, as the maggot of the fly lives in horse-dung" (*cf.* Macleay, *loc. cit.* pp. 204–205).

Glossina palpalis is the *darkest* of all the species of *Glossina*, and cannot well be confused with any other, with the exception of *Gl. pallicera*, Bigot (*q.v.* for distinctive characters).

As compared with *Glossina morsitans*, Westw., the inner margins of the eyes in both sexes are more parallel, and the eyes are usually wider apart at the vertex. Moreover, from this species, as from *Gl. longipalpis*, Wied., it is distinguished at once by the entirely black hind tarsi.

Glossina pallicera, Bigot.

(Plate II.)

Glossina pallicera, Bigot, Annales de la Société Entomologique de France, Année 1891, Vol. LX., p. 378.

♂, ♀. Length, 8 millim. ($3\frac{2}{3}$ lin.); length of wing, 8 millim.

Brown; thorax mouse-gray with brown, sometimes confluent markings; antennæ orange-buff,†; abdomen with no conspicuous markings, except a narrow pale median triangle on the second segment, and yellowish-cinerous triangular lateral markings (scarcely visible from above) on the segments from the third to the sixth; legs pale ochraceous; hind tarsi, and tips of last two joints of front and middle pairs, dark brown; wings brown.*

This species can only be confused with *Gl. palpalis*, R.-Desv., from which it is at once distinguished by the colour of the antennæ.

Head.—Frontal stripe ochraceous; frontal margins yellowish-cinereous; face buff, with a whitish shimmer; palpi ochraceous-buff, infuscated at the tips; bulb at base of proboscis pale ochraceous; arista buff-coloured, dark brown on the under side at the base.

Thorax.—The pattern of the dark-brown markings is the same as in *Gl. palpalis*; in the single ♀ before me the markings are more or less confluent, so that the dorsum of the thorax appears of a mottled brown colour; the impressed suture and remains of the cinereous stripe on each side of the confluent

* Ridgway, "Nomenclature of Colors" (1886), Pl. II.
† *Ibid.* Pl. VI.

ad-median brown stripes in front, paler; humeral calli and pleuræ cinereous; scutellum cinereous at the base, ochraceous buff on the distal half, with the usual dark-brown patches, one on each side of the longitudinal median impression, separated by a rather wide interval in the typical specimens.

Abdomen.—With the exceptions mentioned above, unicolorous; the typical ♂ has the hind margins of the second, third and fourth segments, and a median stripe on the two latter darker than the remainder of the upper side of these segments, so that the third and fourth segments appear to be marked with an interrupted transverse band, somewhat paler than the ground colour; this, however, is probably an effect of drying; seventh segment and hypopygium in the ♂, and seventh segment, at least at the sides, in the ♀ clothed with yellowish cinereous dust.

Squamæ yellowish white; fringe of antisquama brown; *halteres* yellowish.

Distribution of *Gl. pallicera*, Bigot.

Nothing is known as to the geographical range of this species. The above description has been drawn up from the examination of Bigot's actual type (which is a ♂ and not a ♀, as stated by him) and a second specimen, a ♀, which had been placed by Bigot above the label "*G. longipalpis*" (= *Gl. palpalis*, Rob.-Desv.), but certainly belongs to the present species. Both of these specimens, the only ones that I have seen, are from Assinie, Ivory Coast (*Ch. Alluaud*) [V.]

Habits, etc.

Unknown.

Synonymy and Affinities.

Although it was suggested by Bigot (*loc. cit.*) that *Gl. pallicera* is perhaps merely a variety of "*G. longipalpis*" (= *Gl. palpalis*, Rob.-Desv.), it appears to me to be quite distinct and fully entitled to specific rank. I express this opinion with the greater confidence, since I have been enabled to examine a specimen of each sex. *Gl. palpalis* is the only species with which *Gl. pallicera* can be confused, but, although closely allied, it can readily be distinguished by the characters given above. In addition to these, the *front in both sexes of* Gl. pallicera *is conspicuously narrower than in* Gl. palpalis. In the ♂ the arista of *Gl. pallicera* is

stouter and longer, but in the ♀ the difference, if any, is less noticeable.

Except for the more or less distinct pale triangle on the second segment, there is no trace of a pale median longitudinal stripe on the abdomen of *Gl. pallicera*, and the narrow pale hind margins to the abdominal segments, usually distinguishable in the case of *Gl. palpalis*, are likewise absent. Thus the abdomen of *Gl. pallicera* is unicolorous, though the presence of the narrow lateral cinereous triangles on the segments from the third to the sixth shows the connection with *Gl. palpalis*, in which the banded type is clearly traceable, though far less distinct than in *Gl. morsitans*, *longipalpis*, or *pallidipes*.

Glossina morsitans, Westw.

(Plate III.)

Glossina morsitans, Westwood, Proc. Zool. Soc. Lond., Pt. XVIII., p. 261, Pl. IX., figs. 1, 1^a–1^f (1850); Kirk, "On the 'Tsetse' Fly of Tropical Africa" (*Glossina morsitans*, Westwood), Journ. Linn. Soc., Zoology, Vol. VIII., pp. 149–156 (1865); Westwood, Oates' "Matabele Land and the Victoria Falls," Appendix, pp. 363–364, Pls. G, fig. 2, and H, figs. 5, 5^a, 5^b (1881): Bigot, Ann. Soc. Ent. France, 6^e Série, T. 5, p. 123 (1885): V. von Röder, Jahrb. der Hamb. Wissensch. Anstalten, X. 2, p. 205 (1893).*

Glossina longipalpis, Macquart (*nec* Wiedemann), Diptères Exotiques, Suppl. IV., p. 239, Tab. 22, fig. 4 (1850); ? Schiner, Reise der Österreichischen Fregatte Novara, Zoologischer Theil. Bd. II., Diptera, p. 311 (1866).

♂, ♀. Length, $7\frac{2}{3}$ to $9\frac{2}{3}$ millim. ($3\frac{3}{5}$ to $4\frac{1}{2}$ lin.); length of wing, $7\frac{1}{2}$ to 9 millim. ($3\frac{1}{2}$ to 4 lin.); width of head, $2\frac{1}{2}$ to $2\frac{2}{3}$ millim. ($1\frac{1}{5}$ to $1\frac{1}{3}$ lin.); width of front at vertex in ♂ $\frac{1}{5}$, in ♀ $\frac{1}{4}$ of total width of head measured across middle of eyes.

Thorax mouse-grey†, *often somewhat paler in front, with more or less distinct brownish longitudinal markings; abdomen varying from drab-grey* † *to ochraceous-buff*,‡ *the segments from the third to the sixth inclusive with very conspicuous dark-brown bands, interrupted*

* Record of the finding of the species by Dr. Fr. Stuhlmann at Mbusini, in Usegua, German East Africa, 27. viii. 1888.

† Ridgway: "Nomenclature of Colors," Pl. II.

‡ Ridgway, *op. cit.* Pl. V.

in the median line, not reaching the lateral margins, and not extending beyond the basal three-fourths of each segment, if so far; tips of the last two joints of the front and middle tarsi dark brown or black, sharply contrasting with the rest of the leg.

Head.—Pale yellow, occipital surface entirely clothed with cinereous dust; frontal stripe varying from buff to ochraceous, face paler, clothed at the sides and below with yellowish silvery dust; sides of front and ocellar triangle also clothed with yellowish or greyish-yellow dust; a more or less distinct dark brown spot on each side of the front below, and the upper portion of the frontal stripe also sometimes infuscated; base of each vertical bristle marked with a dark-brown spot, but not connected by a dark-brown band; bristles on the vibrissal ridges not extending higher than the middle. Chitinised patches in roof of buccal cavity brown. *Antennæ* greyish-buff to cinereous, third joint often strongly infuscated, except at the extreme base; second joint usually more or less brown in front, except at the tip; arista buff, dark-brown at the base beneath. Bulb at base of proboscis dark-brown to reddish-brown. *Palpi* buff, more or less cinereous above, the tips infuscated.

Thorax.—The markings on the dorsum are vestiges of those described in the case of *Gl. palpalis;* they are usually more or less indistinct; pleuræ cinereous; in rubbed specimens the dorsum may appear reddish-brown. Scutellum buff, with the usual patch on each side of the median line greyish-brown.

Abdomen.—In addition to the interrupted dark-brown bands, an ill-defined brown patch on the second segment on each side, not extending to the lateral or hind margins; the dark-brown interrupted bands taper towards the lateral margins, and at the median interruption, though sometimes straight-cut, are generally more or less rounded off; on the posterior angles of the segments the pale hind margins are continuous with what in *Gl. palpalis* and *Gl. pallicera* are the lateral triangles; seventh segment and hypopygium in the ♂ cinereous buff; seventh segment in the ♀ with a more or less distinct indication of the interrupted dark-brown band at the base.

Legs buff-coloured, the front femora on the inside, the middle and hind femora on the outside more or less infuscated; sometimes a small dark patch on the outside of the front femora also beyond the middle; hind tarsi with the last two joints (except the extreme base of the penultimate) entirely black.

Wings faintly brownish. Squamæ white, fringe of antisquama darker, as usual. Halteres pale yellow.

With reference to Westwood's original figure of *Gl. morsitans* (P. Z. S. 1850, Pl. xix, Fig. 2), it is perhaps worthy of note that the head of the typical specimen, which is there represented, has at some time or other become detached from the body, and has subsequently been glued on in an unnatural position, the vertex being attached to the front of the thorax in such a way that the long axis of the head is almost horizontal. Curiously enough this defect was faithfully reproduced by Westwood in his drawing, which thus gives an altogether distorted idea of the appearance of the head of the insect when seen from above.* Westwood's type is in very poor condition, especially as regards the thorax, which is denuded and almost entirely destitute of the greyish dust with which it is normally clothed, so that the ground colour appears ochraceous-buff, with four rather broad black stripes, interrupted at the suture, the lateral stripes abbreviated in front, the middle pair behind. These stripes, which are shown in Westwood's figure, are not nearly so distinct in well-preserved specimens, since they are normally to a large extent concealed by the greyish dust with which the ground colour of the thorax is obscured.

Distribution of *Gl. morsitans*, Westw.

The above description has been drawn up from an examination of seventy-one specimens (50 ♂♂, 21 ♀♀), as follows:—

1 ♂, the type of the species, locality uncertain† (Major Frank

* Westwood's figure was reproduced on the title-page of Livingstone's "Missionary Travels and Researches in South Africa," and also on p. 571 of that work, where it is accompanied by a copy of Westwood's figure of the head and mouth parts, and by a rough original wood-cut representing the fly nearly natural size. In the Appendix to Oates' "Matabele Land and the Victoria Falls," p. 364, Westwood mentions that his figure was copied upon the title-page of Livingstone's work "without acknowledgment," but from Livingstone's own statement (*op. cit.* p. 571) it is clear that he sinned in ignorance, since the drawing was supplied to him by Mr. J. E. Gray, of the British Museum.

† The specimen bears the following label, in Westwood's handwriting:—"Glossina morsitans, Westwood (Setse), fm. Lake Tchad, Central Africa. Captn. Frank Vardon"; but this locality must be wrong. So far as I can discover, Major Vardon never visited Lake Tchad, and the specimen is almost certainly from the Siloquana Hills, which are in the north of the Transvaal, in the angle formed by the Nylstroom River with the Limpopo. The late Wm. Cotton Oswell, who was a companion of Vardon on his shooting expeditions (*cf.* "Big Game Shooting," Vol. I., pp. 88, 89), writing in "Big Game Shooting," Vol. I., p. 113 (The Badminton Library, London, Longmans, Green & Co., 1894), says:—"On the low Siloquana Hills near this we made our acquaintance with the Tsétsé fly, which we

Vardon) [O.]; 1 ♂, Grahamstown,* Cape Colony (purchased from Higgins, 1869) [O.]; 1 ♂, 1 ♀ Zululand [V.]; 2 ♂♂, Little Crocodile R., two days' march from Barberton, Transvaal, 28. x. 1888 (*R. Crawshay*); 2 ♂♂, 1 ♀, same locality and date as the last (*R. Crawshay*) [C.]; 1 ♂, Loewe's Creek, Barberton, 1893 (*Dr. Percy Rendall*) [W. L. Distant]; 9 ♂♂, Tzende R.,† Zoutpansberg District, N.E. Transvaal, 2, 3. vii. 1896 (*C. Heseltine*); 3 ♂♂, 1 ♀, between Tati and Gwailo R., Matabeleland, 1873 (*F. Oates*) [O.]; 2 ♂♂, Beira Railway, Lower Pungwe River, Portuguese East Africa, Oct. 1897: "Flew into railway carriage at night, attracted by the light" (*G. A. K. Marshall*); 4 ♂♂, 2 ♀♀, Umfuli R., Rhodesia, Sept. 1895 (*G. A. K. Marshall*); 1 ♂, Northern Zambesia, between 15° and 18° S.;

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were the first to bring to notice; Vardon taking or sending to England some he caught on his favourite horse." The year to which this refers was apparently 1845 (*cf.* Oswell, *op. cit.*, pp. 36, 87, 88). In a letter to Westwood, dated May, 1850 (published by Westwood, P.Z.S. 1850, p. 260), Vardon speaks of "the fly of South Africa so destructive to cattle," and further on he writes: "The specimens you saw cost me one of the best [horses] in my stud." Kirk (Journ. Linn. Soc., Zoology, Vol. VII., p. 150) speaks of Vardon as having "hunted about the same time and in the same region as Gordon Cumming," and a little later Kirk goes on to say: "Major Vardon further performed a most interesting experiment. Aware of the existence in certain districts of the Bechuana country of plants poisonous to cattle (such as the 'Koñwhane,' a species of *Lasiosiphon*), and suspecting that some such herb might be the cause of the mischief ascribed by the natives to the fly, he put the matter to the test by riding his horse into a "Tsetse"-infested part, without dismounting or allowing the animal to feed; the result was the death of the horse." It can scarcely be doubted that this incident is the same as that referred to by Vardon himself in his letter to Westwood quoted above, and also alluded to as we have seen by his companion Oswell. If so, the true locality of the type of *Gl. morsitans* may be regarded as established with sufficient certainty.

* This locality also requires confirmation: the specimen is labelled, in Westwood's handwriting—"Grahams Town, South Africa. Higgins, 1869"; but though Vardon was wrong in supposing that *Glossina morsitans* "is not met with south of the Tropic of Capricorn," further evidence is needed before we can believe that it occurs in the South of Cape Colony, within eighty miles of Port Elizabeth.

† The total number of specimens of *Gl. morsitans* brought back by Mr. Heseltine from this locality was fifteen, all of which were males. From maps kindly lent me by Mr. Heseltine, with the localities marked, it appears that he found the fly on the Singwedsi River, where it crosses the boundary between the Transvaal and Portuguese E. Africa, just south of Lat. 23° S., and west of Long. 32° E. This district is within thirty miles of the valley of the Limpopo, and the Singwedsi runs S.E. to join Olifant's River, a tributary of the Limpopo. Mr. Heseltine also met with the fly on the Great Letaba River, where it turns N.E. and crosses Long. 31° E., while the specimens captured were taken on the Tzende River where it crosses the Tropic of Capricorn, a few minutes west of Long. 32° E. The Tzende River runs nearly due south to join the Great Letaba River, which falls into Olifant's River. All these localities are in the N.E. corner of the Transvaal.

and 24° and 28° E. (*Wm. Oswell*)*; 1 ♂, same locality as the preceding (*Wm. Oswell*) [O.]; 2 ♂♂, 2 ♀♀, Lake Mweru (S.W. of Lake Tanganyika), 31. vii. 1892 (*R. Crawshay*) [C.]; 1 ♀, Henga, *circa* 3,300 ft. (south-west from northern end of L. Nyasa, between 10° and 11° S. lat.), between July and Dec., 1893 (*R. Crawshay*) [C.]; 1 ♀, Msongozi's, Loangwa Valley, Senga, British Central Africa, 2,300 ft., Sept. 3, 1895 (*R. Crawshay*); 2 ♂♂, 2 ♀♀, Kilima Njaro (*F. J. Jackson*); 2 ♂♂, "E. Africa" (*Capt. Speke*); 3 ♂♂ (fragments gummed on card), ? Locality (*Dr. Livingstone*) [O.]; 10 ♂♂, 10 ♀♀, Togo, W. Africa (*Dr. Schilling*) [Royal Zoological Museum, Berlin]; 1 ♂, ? Locality and collector [O.]; 2 ♂♂, ? Locality and collector [V.].

Since *Glossina morsitans* has hitherto undoubtedly been confounded with *Gl. pallidipes* (not to speak of *Gl. longipalpis*) under the comprehensive term "Tsetse-fly," it is impossible to draw any trustworthy conclusions as to the precise geographical range of this species from statements in records of African travel and sport. A study of the foregoing list of localities of actual specimens, however, will show that *Gl. morsitans* certainly occurs —not, of course, continuously, but in "fly-belts"—from Zululand and the south-eastern portion of the Transvaal in the south to Kilima Njaro in the north, while the fact that the species has recently been collected by Dr. Schilling in Togoland on the Slave Coast, shows that it can no longer be regarded as confined to South or even Central Africa, but that its limits are very much wider than has hitherto been supposed. As will be shown below, it is probable that the species which was the subject of Lt.-Col. Bruce's memorable investigations in Zululand was *Glossina pallidipes* and not *Gl. morsitans*, and if this is the case the eastern halves of the areas of distribution of the two species practically coincide. For while *Gl. morsitans* also occurs in Zululand (two specimens from this region are in the collection of Mr. G. H. Verrall), as has already been seen, the Museum possesses specimens from Kilima Njaro, which is less than one hundred miles south of Witu Forest, the most northerly locality from which specimens of *Gl. pallidipes* have at present been received. Until a large amount of material has been systematically collected, any more precise statement as to the relative distribution of *Gl. morsitans* and *Gl. pallidipes* is impossible.

* *Cf.* Trans. Ent. Soc. Lond., New Ser., Vol. II. p. 96 (1852, 1853) Ann. Mag. Nat. Hist., Ser. 2, Vol. X. (1863).

HABITS, ETC. (See Chapter I.).

It has already been pointed out at the commencement of Chapter I. that the name *Glossina morsitans* is usually quoted as if it were that of the only known species of the genus. Although this, of course, is a mistake, nevertheless, if it is permissible to draw any conclusion from the material at present available for examination, *Gl. morsitans* is one of the two commonest Tsetse-flies of South and Central Africa. But since its range in this region is practically co-extensive with that of *Gl. pallidipes*, all statements in accounts of South African travel and sport as to the occurrence and habits of "the Tsetse-fly" or "the South African Tsetse-fly" must for the present be regarded as referring to both species indiscriminately: while owing to the fact that both *Glossina longipalpis* and *Gl. palpalis* would appear also to occur on the Zambesi, some of the phenomena hitherto attributed to *Gl. morsitans* should perhaps really be ascribed to one or both of the latter species. With this explanation, readers who desire to learn the habits of *Glossina morsitans* may be referred to Chapter I., where all that is known on this subject will be found fully discussed.

It will have been noticed that, in the foregoing list of specimens examined, out of seventy-one examples only twenty-one are females. The whole of the fifteen specimens, too, brought back by Mr. Christopher Heseltine from the Tzende River were males, as were also the six specimens of *Glossina palpalis* taken by the author in Sierra Leone; while out of fifty specimens of *Gl. pallidipes* from Machakos, only three are females. This would suggest the idea that in some at least of the species of *Glossina* the two sexes may have slightly different habits (although they both suck blood *), in consequence of which the female is more easily able to escape observation or avoid capture: it should be noted, however, that in the twenty specimens of *Gl. morsitans* collected by Dr. Schilling, in Togo, the sexes are equally divided. In view of the above facts there can be little doubt that Sir John Kirk's statement [28] that only on one occasion did he "obtain two of what may be the male insect," was due to his having confused the sexes, unless indeed he happened to have collected at a season when the usual ratio of the sexes was reversed.

* Among the Tabanidæ (Horse-flies), in which the females alone suck blood, while the males frequent flowers, the *females* are much the more common.

Synonymy and Affinities.

There can be no question of the correctness of the identification of *Glossina morsitans*, Westw., as defined above, and although the specific name has no doubt often been used loosely in what may be termed a *generic* manner, while Continental writers have occasionally referred to the species as if it were Wiedemann's *longipalpis*, the species itself has never been re-described under any synonym.

Glossina morsitans, Westw., *Gl. longipalpis*, Wied., and *Gl. pallidipes*, sp. nov., form a group of closely allied species, of which *Gl. palpalis*, Rob.-Desv., is a somewhat more distant connection. A discussion of the distinctive characters will be found on pp. 93–95, under *Gl. longipalpis*.

Glossina pallidipes, sp. nov.

(Plate IV.)

♂, ♀. Length, 8 to 10 millim. ($3\frac{3}{4}$ to $4\frac{2}{3}$ lin.); length of wing, $8\frac{2}{3}$ to $9\frac{1}{4}$ millim. ($4\frac{1}{4}$ to $4\frac{1}{2}$ lin.); width of head in male, 3 millim. ($1\frac{1}{2}$ lin.), in ♀ $2\frac{2}{3}$ millim. ($1\frac{1}{3}$ lin.). Width of front at vertex in ♂ $\frac{1}{7}$, in ♀ between $\frac{1}{5}$ and $\frac{1}{4}$ of total width of head measured across middle of eyes.

Precisely similar to Gl. morsitans *in colouration and general appearance, but distinguishable at once by the front and middle tarsi being entirely yellow*; the interrupted bands on the abdomen generally darker, and approaching closer to the hind margins of the segments (the pale hind margin usually confined to the posterior sixth or fifth of each segment).*

As compared with *Gl. morsitans*, this species, in addition to the differences already mentioned, is often distinctly larger; the *eyes* are larger and more prominent, while the *front* in the ♂ is (actually and not merely relatively) narrower, and also as a rule somewhat darker towards the vertex; the ground-colour of the *abdomen* is ochraceous-buff to ochraceous; the pale hind margins of the segments from the 3rd to the 6th inclusive are narrower than in *Gl. morsitans*, and sometimes exceedingly narrow, so that

* In specimens preserved in spirit the last two joints of the front tarsi sometimes appear faintly tipped with pale brown.

the interrupted dark-brown bands occupy more of the upper surface of the abdomen.

Legs buff-coloured; middle tarsi, like the front pair, entirely pale*; the last two joints of the hind tarsi (except the penultimate at the extreme base) dark-brown.

The typical specimens are a ♂ and ♀ from Kilima Njaro (*F. J. Jackson*), in the British Museum collection.

Varieties.—A ♂ and ♀ from Witu, "caught in Witu town" (*British East Africa Company*), are much below the normal size, since they do not exceed 7½ millim. (3½ lin.) in length; they are further distinguished by the pale longitudinal stripe on the median line of the abdomen being wider than usual, especially in the ♀, in which also it is less sharply defined, owing to the interrupted dark transverse bands dying away towards the median line. In the shape and size of the eyes, and especially in the narrowness of the front in the male, however, these specimens agree with the typical form.

Several specimens from British East Africa (*Vet.-Capt. A. J. Haslam*) and Kilima Njaro (*F. J. Jackson*), though otherwise agreeing with the typical form, have the median pale longitudinal stripe on the abdomen wider and less sharply defined, since the interrupted dark transverse bands die away towards the median line. Possibly this appearance is in part at least due to immaturity.

Distribution of *Gl. pallidipes*, sp. nov.

Of this species, which would appear to be the East African representative of *Gl. longipalpis*, Wied., I have examined a series of 81 specimens (63 ♂♂ and 18 ♀♀), from various localities, as indicated below:—

1 ♂, locality unknown (forwarded for identification by Mr. J. F. Quekett, Durban Museum); 1 ♀, "Country south of Mashonaland" (*Mr. Hooke:* presented by the late J. C. Mansel-Pleydell); 1 ♂, Shire Highlands, 1893 (*H. H. Johnston.*—"Caught in a part of the Shire Highlands where we had thought there was no Tsetse": extract from letter from Mr. Johnston (now Sir H. H. Johnston, K.C.B.), dated October 22nd, 1893, to the late Sir Wm. Flower, K.C.B., enclosing specimen); 2 ♂♂, British Central Africa—exact locality uncertain, but probably Lunyina River, Henga—1895 (*R. Crawshay*); 1 ♂, Lake

* See note on page 87.

Mweru, 18–22, III. 1892 (*R. Crawshay*); 3 ♂♂, 3 ♀♀ (including the types of the species), Kilima Njaro (*F. J. Jackson*); 1 ♀, Kiboko River, Uganda Railway, British East Africa, Nov., 1898 (*R. Crawshay*:—"settled on back of collector's neck and bit him": letter from Mr. L. R. Crawshay, April 13, 1902) [C.]; 1 ♀, Upper Sabaki River, 1890 (presented by the late British East Africa Company); 3 ♂♂, 1 ♀, Uganda Railway, British East Africa, 1897–98 (*Vet.-Capt. A. J. Haslam*); 1 ♀, Uganda Railway (*C. S. Betton*); 47 ♂♂, 3 ♀♀, Machakos, 1897, and 2 ♂♂, 2 ♀♀, Tsavo River (received from the Tsetse-fly Committee of the Royal Society, per Lt.-Col. Bruce); 1 ♂, 2 ♀♀, "E. Africa" (*Capt. Speke*); 2 ♂♂, 1 ♀ (including the two specimens of the small variety mentioned above), "caught in Witu Town," 1891 (*Officer in charge of British East Africa Company's Station at Lamu:* presented by the late British East Africa Company); 2 ♀♀, Witu Forest, 1895 (*the Sultan of Witu:* presented by the late W. S. Godfrey).

It has already been pointed out in dealing with the area of distribution of *Gl. morsitans* that the eastern half of it practically coincides with that of the present species, and reference has been made to the probability that the species that formed the subject of Lt.-Col. Bruce's experiments in Zulu Land was *Gl. pallidipes* and not *Gl. morsitans*. Such at any rate is the natural deduction from a comparison of the reproductions of photographs of specimens on Plate II. of Col. Bruce's memoir [142]; on comparing fig. 2 and the right-hand figure of fig. 7, it will be seen that the median pale streak on the abdomen is very narrow, and that the dark interrupted bands extend close to the posterior borders of the segments. The coloured figures on Plate I. are evidently less reliable, and no importance can be attached to the obvious discrepancies between them and the photographic reproductions on the following plate. In the coloured figures the angles of the interrupted dark abdominal bands are shown rounded off, while the pale hind margins are deeper and the median stripe wider, so that to judge from the abdomen these figures would appear to have been taken from specimens of *Gl. morsitans*. On the other hand, the front tarsi are entirely pale; but, since the hind tarsi are likewise shown without dark tips, no conclusion can be drawn from this, except that the artist certainly did not examine the legs of his specimens closely. It is quite possible that in his experiments Bruce may have made use of both *Gl. morsitans* and *Gl. pallidipes*.

Habits, etc.

See Chapter I.

The fact that, as recorded above, three specimens were actually caught "in Witu Town"* is of special interest, since it is commonly supposed that the Tsetse avoids the neighbourhood of human habitations. Thus, Livingstone [21] writes of the "well-known disgust which the Tsetse shows to animal excreta, as exhibited when a village is placed in its habitat;" and Sir H. H. Johnston [145] says: "This insect has a . . . still stronger dislike to a congeries of human habitations. . . . They [horses and cattle] are also quite safe in the middle of any collection of huts or in any town."

Synonymy and Affinities.

As has already been mentioned, *Gl. pallidipes* has not hitherto been distinguished from *Gl. morsitans*, Westw., which forms with it and *Gl. longipalpis*, Wied., a closely allied group. Its distinctive characters will be discussed further in dealing with the latter species (see p. 93), to which it presents an exceedingly close resemblance.

Glossina longipalpis, Wied.

(Plate V.)

Glossina longipalpis, Wiedemann, "Aussereuropäische zweiflügelige Insekten," Zweiter Theil, p. 254, Taf. IX. fig. 10, *a*, *b*, *c* (1830); Macquart, Hist. Nat. des Ins. Diptères., T. ii., p. 245 (1835); Dipt. Exot., T. ii., 3, p. 113, Tab. 14, fig. 1 (1843).

♂, ♀.—Length, 9 to 10 millim. ($4\frac{1}{4}$ to $4\frac{2}{3}$ lin.); length of wing, 8 to $9\frac{1}{4}$ millim. ($3\frac{3}{4}$ to $4\frac{1}{2}$ lin.); width of head, in both

* The following is an extract from the "Report of the Officer in Charge of the British East Africa Company's Station at Lamu" to the late British East Africa Company, sending the specimens, and dated May 26, 1891:—"I beg to forward specimens of two species of flies. The three smaller ones, which I believe to be the true "Tsetze," or a species of it, I caught in Witu Town, and caught others between Funga Sormbe and Witu. This fly is also plentiful along the road between Mombasa—Gulu-Gulu—Teita and Kibwezi in Ukambani. Its bite, though very sharp and needle-like, causes little or no irritation." The other flies sent were specimens of *Tabanus latipes*, Macq., one of the commonest of the African Tabanidæ (horse-flies), which ranges from Senegal to British East Africa and southwards to Natal.

sexes, 3 millim. ($1\frac{1}{2}$ lin.); width of front at vertex in ♂ $\frac{1}{6}$, in ♀ between $\frac{1}{5}$ and $\frac{1}{4}$ of total width of head measured across middle of eyes.

Thorax olivaceous-gray, with the usual dark-brown longitudinal markings; abdomen ochraceous-buff, with interrupted dark bands, which stand out conspicuously from ground-colour, and leave hind margins of segments only narrowly pale; sides of front in ♂ parallel, in ♀ converging slightly towards vertex; legs ochraceous-buff, last two joints of front and middle tarsi with sharply defined black tips as in* Gl. morsitans.

Very close to *Gl. pallidipes*, Austen, but distinguished at at once by the black tips to the last two joints of the front and middle tarsi. *Eyes* in ♂ large and tumid, resembling the eyes of *Gl. pallidipes* more than those of *Gl. morsitans*. *Front* of ♂ not quite so narrow as that of ♂ *pallidipes;* frontal stripe tawny, darker above, frontal margins and vertical triangle olivaceous-gray; elongate dark-brown spot on each side of frontal stripe below generally very conspicuous, as is also the narrow dark-brown band connecting the bases of the vertical bristles.

Dorsum of thorax with the brown markings described in the case of *Gl. palpalis* fairly distinct. *Scutellum* buff, grey at the base, with a strongly marked dark-brown triangular spot on each side of the median line.

Abdomen, with the usual interrupted dark-brown bands on the third to the sixth segments inclusive, strongly marked and deep, precisely as in *Gl. pallidipes*, leaving the hind margins of the segments only narrowly pale.

Legs buff, the front femora strongly infuscated on the inner side, and generally more or less infuscated on the outer side also. Middle femora usually more or less infuscated on the outer and inner side; hind femora slightly infuscated on the outside towards the distal extremity. Middle and hind femora often with a strongly marked elongate black spot on the under side near the end.

Distribution of *Gl. longipalpis*, Wied.

The above description is based on an examination of twenty-three specimens (14 ♂♂, 9 ♀♀) from the following localities:—

1 ♂, the type of the species, "Guinea" [Imperial and Royal

* Ridgway, "Nomenclature of Colors," Pl. V. fig. 10.

Natural History Museum, Vienna]; 1 ♀, locality uncertain, labelled "*Glossina longipalpis* ♂, Wied." in what is probably Macquart's handwriting [V.]; 12 ♂♂, 8 ♀♀, Togo (*Dr. Schilling*) [Royal Zoological Museum, Berlin]; 1 ♂, "Zambesi" (*Dr.* (now *Sir*) *John Kirk*).

Habits, etc.

See p. 86. We have as yet no special information concerning the habits of *Gl. longipalpis*, Wied.

Synonymy and Affinities.

A glance at the synonymy already given under *Glossina palpalis*, Rob.-Desv., and *Gl. morsitans*, Westw., will show that both of these species have at one time or another been mistaken for *Gl. longipalpis*, Wied. As pointed out on p. 77, to judge merely from the description, the latter species would seem to have been described from a specimen of *Gl. palpalis* "with pale legs, and well-marked pale median stripe and hind margins to the abdominal segments (*i.e.* var. *tachinoides*)"; moreover, as is further pointed out in Note (†) on the same page, Wiedemann's figure, valueless as it is, would support this conclusion "by conveying the impression of a species with very dark abdomen and well-marked pale hind margins to the abdominal segments." With only the description to rely on, the present writer had previously identified the Tsetse-flies found by him at Sierra Leone in 1899 as *Gl. longipalpis*, Wied.,*—a determination made with the greater confidence, since Wiedemann states in his description that the type of the species is from Sierra Leone, where it had been discovered by Adam Afzelius.† On examining the specimen received from the Vienna Museum as the type, however, it was at once seen that this belongs to a species quite distinct from that described above as *Gl. palpalis*, Rob.-Desv., and a doubt naturally arose as to whether the so-called type was the true one, especially as the label attached to the specimen bears the locality "Guinea" (instead of Sierra Leone), in addition to the words "Glossina longipalpis, Wied." I therefore applied again to Herr Josef Bischof, of the Vienna Museum, from whom I had received the insect, and obtained the following

* *Cf.* Austen [162].

† A well-known Swedish botanist, who visited Free Town, Sierra Leone, in the years 1792 and 1794, and made general collections of zoological and botanical specimens.

reply, dated "Vienna, 18. iii. 1902."—"The specimen sent is the original type. The label placed beside it is Wiedemann's original one, and bears his handwriting." In view of this statement it is useless to dilate further upon apparent discrepancies between description and type, and the species described above must be taken as the true *Glossina longipalpis*, Wied.

As has already been stated in speaking of the affinities of *Gl. morsitans* (p. 87):—"*Glossina morsitans*, Westw., *Gl. longipalpis*, Wied., and *Gl. pallidipes*, sp. nov., form a group of closely allied species, of which *Gl. palpalis*, Rob.-Desv. is a somewhat more distant connection." Through all of these species there can be traced with greater or less distinctness the fundamental system of abdominal markings, consisting essentially of a series of dark transverse bands, interrupted on the median line, and occupying a larger or smaller area of the upper surface of the segments. *Gl. palpalis*, however, is distinguished at once by its entirely dark hind tarsi.

Of the remaining species *Gl. pallidipes* is distinguished from the other two by the front and middle tarsi being entirely pale, and in the ♂ by the narrower front. The absence of the dark tips to the last two joints of the front and middle tarsi seems to be a reliable character, and one that cannot be due to possible bleaching or immaturity, since the last two joints of the *hind* tarsi are invariably dark. Altogether there need, I think, be no hesitation in accepting *Glossina pallidipes* as a good species. Apart from the tarsi, females of *Gl. pallidipes* are not easy to distinguish from females of *Gl. longipalpis*, though from females of *Gl. morsitans* they are readily distinguishable by the depth of the abdominal bands. In both sexes, too, *Gl. pallidipes* may easily be distinguished from *Gl. morsitans* by the shape of the third joint of the antenna, which in the former species is long and narrow, with the apex pointed and (especially in the female) conspicuously turned forwards; in *Gl. morsitans* the third joint of the antenna is shorter and much broader (about half as broad again as in *pallidipes*), and darker towards the tip, which is blunter and not so much turned forwards; the *arista* is also shorter in *morsitans* than in *pallidipes*. To facilitate comparison, the antennæ should be removed with the point of a fine scalpel, mounted in glycerine and examined under a lens. As regards the males, even though the front and middle tarsi be wanting, a male of *pallidipes* can be distinguished from a male of *longipalpis*, by the front being narrower, especially at the vertex,

towards which its sides distinctly converge; and a male of *Gl. longipalpis* can be distinguished from males of both *morsitans* and *pallidipes* by the inner margins of the eyes, forming the sides

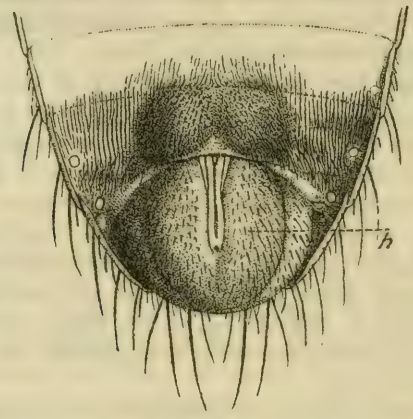

Fig. 12.
Distal portion of abdomen of *Glossina morsitans*, Westw. (ventral aspect), showing (*h*) hypopygium. (× 15.)

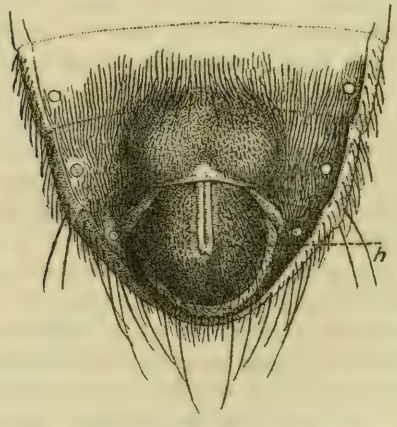

Fig. 13.
Distal portion of abdomen of *Glossina longipalpis*, Wied. (ventral aspect), showing (*h*) hypopygium. (× 15.)

of the front, being parallel instead of converging towards the vertex. Similarly, the shape and size of the hypopygium, as already described in the "Synopsis of Species" (see pp. 70–71),

will serve to distinguish a male of *longipalpis* from a specimen of *morsitans* belonging to the same sex (see Figs. 12 and 13).*

We have as yet no information as to the western limit of *Gl. pallidipes*, so that at present it may be regarded as the eastern representative of *Gl. longipalpis*.

Glossina fusca, Walk.

(Plate VI.)

Stomoxys fuscus, Walker, List Dipt. Ins. in Coll. Brit. Mus. Pt. III. p. 682 (1849).—♀.

Glossina tabaniformis, Westwood, Proc. Zool. Soc. Lond. Pt. XVIII. p. 268, Pl. XIX. fig. 3 (1850).—♀.

Glossina fusca, Walker, "Entomologist," VI. p. 328 (1873).

Glossina grossa, Bigot, Ann. Soc. Ent. Fr. Vol. LX. p. 377 (1891).—♀.

Glossina tabaniformis, Stuhlmann, Ber. üb. Land- u. Forstwirtsch. in Deutsch-Ostafrika, 1 Bd., Heft. 2, p. 173 (1902).

♂, ♀.—Length 11 to 12 millim. ($5\frac{1}{5}$ to $5\frac{3}{5}$ lin.); length of wing $10\frac{2}{3}$ to 13 millim. (5 to $6\frac{1}{4}$ lin.); wing expanse of largest ♂ 26 millim. ($12\frac{1}{2}$ lin.); wing expanse of largest ♀ 29 millim. ($13\frac{3}{5}$ lin.); width of head in ♂ $3\frac{1}{2}$ millim. ($1\frac{3}{5}$ lin.); in ♀ $3\frac{1}{4}$ millim. (Walker's type) to $3\frac{3}{4}$ millim. ($1\frac{1}{2}$ to $1\frac{3}{4}$ lin.); width of front at vertex, in ♂ $\frac{2}{3}$ millim. ($\frac{1}{3}$ lin.), in ♀ $\frac{3}{5}$ to 1 millim. (just under $\frac{1}{2}$ lin.).

Thorax drab-gray † *to grayish brown, with narrow darker longitudinal stripes; abdomen russet brown,*‡ *segments after the second mummy brown,*§ *hind margins towards posterior angles sometimes paler; proboscis bulb pale yellow; legs buff, middle and hind tibiæ sometimes with a well marked dark ring, more or less incomplete, round middle; wings yellowish brown to brownish, sometimes larger and broader in ♀ than in ♂, anterior and posterior transverse veins often infuscated.*

Head.—Buff, posterior surface grayish; *frontal stripe* usually somewhat darker, sometimes ochraceous; *face*, including facial

* The shape and size of the hypopygium in *Gl. pallidipes* are the same as in *Gl. longipalpis*.

† Ridgway, "Nomenclature of Colors," Pl. II. fig. 13.

‡ *Ibid.* Pl. III. fig. 16.

§ *Ibid.* Pl. III. fig. 10.

pit, and frontal margins narrowly, shimmering whitish yellow; *ocellar spot* not, or scarcely darker than frontal stripe; ocelli large, anterior ocellus the largest. Bases of the vertical bristles united by a more or less conspicuous brown band. *Antennæ* buff; second joint on inside, and distal half or two-thirds of third joint brown; second joint sometimes entirely brown. Arista buff, second joint dark-brown at base beneath. *Palpi* buff, upper surface grayish brown, and rather more than apical quarter brown; the row of short erect black bristles along upper margin very conspicuous.*

Thorax.—Series of markings on dorsum, as described for *Gl. palpalis*, much reduced and but little conspicuous; most distinct are the two narrow ad-median stripes in front of the suture, the narrow curved stripe outside these on each side, sometimes with prolongation to anterior margin of thorax, and two faint blotches enclosed by the curved stripe, one in front of and one behind the transverse suture; the small spot on the suture, between the ad-median and the curved stripe on each side more or less distinct; spot on inner margin of humeral callus usually very faint. Scutellum grayish-brown; margin and impressed median line buff.

Abdomen.—The longer hair at the base of the second segment golden-yellow in the middle, dark-brown or black at the sides; third, fourth, and fifth segments very short; a pale median stripe wanting, or scarcely visible if at all, but posterior angles and (usually) more or less of extreme hind margins of the third to the sixth segments inclusive yellowish, so that the colour of these segments is obviously due to dark transverse bands, as in the case of species previously described; seventh segment and hypopygium of ♂ clothed with grayish-yellow dust.

Legs.—Front femora sometimes more or less infuscated on inner side; middle femora with a brownish blotch on under side near tip; solitary bristle on upper side of middle femora near the tip, stout and conspicuous; front tibiæ sometimes with dark brown blotch on inside in middle, representing ring sometimes seen on middle and hind tibiæ; extreme tips of front and hind tibiæ and extreme base of first joint of front and hind tarsi reddish-brown on under side; front and hind tibiæ towards the tips and first three joints of front and hind tarsi clothed beneath

* In Walker's type (a ♀) the bristles on the margin of the buccal cavity below the vibrissal angle are golden-yellow instead of black; a trace of this is sometimes seen in other specimens also.

with short golden pile ; last two joints of front tarsi more or less infuscated at the tips ; last two joints of middle and hind tarsi, except basal half of penultimate joint of middle tarsi, dark brown ; sometimes extreme tips of remaining tarsal joints infuscated ; claws black, russet-brown at base.

Wings.—Veins pale tawny ; upper portion of anterior transverse vein often strongly incrassated, and, together with adjacent portion of fourth vein lying towards base of wing, as well as posterior transverse vein and portion of fourth vein immediately beyond, conspicuously infuscated ; basal portion of the veins from the second to the sixth also darker. *Squamæ* not infuscated, fringed with rather long pale-brown fine silky hair. *Halteres* yellowish.

Since Walker's type is a ♀, and not in the best of condition, the above description has been drawn up from a ♂ from Kaporo, 1670 ft., near Songwi River, N.W. of Lake Nyasa, British Central Africa Protectorate, 28. ii. 1895 (*R. Crawshay*), "Taken on the path at night," and a ♀ from Witu Forest, 1895 (*Sultan of Witu*, presented by the late W. S. Godfrey) ; both of these specimens are in the collection of the British Museum, and have been specially labelled.

In certain specimens, including, as it happens, both the type of the species and also that of *Gl. tabaniformis*, Westw., the anterior transverse vein is less incrassated above than usual, and, like the adjacent portion of the fourth vein lying towards the base of the wing and the posterior transverse vein, is also not infuscated. In these specimens the wing is usually somewhat darker than in those in which the anterior transverse vein is more strongly developed, while, owing to the absence of the infuscations alluded to, it appears of a more uniform brown. There can, however, I think, be no question of a specific difference. The type of *Gl. grossa*, Bigot, is an unusually dark specimen, with the second joint of the antennæ and the abdominal segments after the second dark brown ; the markings on the dorsum of the thorax are also unusually distinct, and the apex of the third joint of the antennæ is very prominent.

It has recently been stated by Stuhlmann [174] that in *Gl. fusca*, which he calls *Gl. tabaniformis*, the ocellar bristles on the crown of the head are wanting, and also that in the resting position the wings are slightly tectiform. Neither of these state-

ments, however, is in accordance with fact. An examination of well-preserved specimens of *Gl. fusca* shows that greater ocellar bristles are present in this as in all other species of *Glossina*; while a specimen from Witu Forest in the British Museum Collection, which has died and been pinned in the resting position, has its wings closed flat over one another just like the blades of a pair of scissors. Moreover, having also examined specimens of *Glossina longipennis*, Corti, *palpalis*, Rob.-Desv., and *pallidipes*, Austen, all pinned in the resting attitude, and having had the opportunity of observing *Gl. palpalis* when alive, I have no hesitation in confirming the statement, as to the resting position of the wings in *Glossina*, in the diagnosis of the genus at the commencement of the present Chapter.

Distribution of *Gl. fusca*, Walk.

Of this species I have been able to examine a series of 22 examples (8 ♂♂ and 14 ♀♀), from various localities, as follows:—

1 ♀, the type of the species, locality unknown; 1 ♀, the type of *Glossina tabaniformis*, Westw., Gold Coast* [O.]; 1 ♂, 2 ♀♀, Gold Coast (received from the Tsetse-fly Committee of the Royal Society, per Lt.-Col. Bruce); 1 ♂, 1 ♀, Togo (*Dr. Schilling*) [Royal Zoological Museum, Berlin]; 1 ♀, the type of *Glossina grossa*, Big., Assinie, Ivory Coast (*Ch. Alluaud*) [V.]; 1 ♀, Asaba, R. Niger (*Dr. W. H. Crosse*); 1 ♂, "country south of Mashonaland" (*Mr. Hooke*: presented by the late J. C. Mansel-Pleydell); 1 ♀, Zambesi (*Dr.* (afterwards *Sir*) *John Kirk*); 2 ♂♂ (including the specimen described in the above re-description), Kaporo, 1670 ft., near Songwi River, north-west of Lake Nyasa, 28. ii. 1895, "taken on the path at night" (*R. Crawshay*); 1 ♂, same locality, 25. ii. 1895 (*R. Crawshay*) [C.]; 1 ♀, Kilima Njaro (*F. J. Jackson*); 1 ♀, Upper Sabaki River, British East Africa (presented by the late British East Africa Company); 1 ♀, Uganda Railway, British East Africa, ? Kiboko

* Westwood [10] writes: "*Hab.* apud littus aureum Africæ tropicalis occidentalis (Mus. D. Hope)." The specimen itself bears on the label "Raddon, Africa," which probably means that it was at one time in the collection of W. Raddon, an English entomologist of the earlier part of last century, well known for his discovery of the caterpillars of the Spurge Hawk-Moth in numbers in North Devon in the year 1814: *cf.* W. Raddon, "Notes on *Deilephila Euphorbiæ*": "Entomological Magazine," II. pp. 535–536 (1835).

River or Sabaki River, near its junction with the Tsavo River,* 1898 (*Vet.-Capt. A. J. Haslam*); 2 ♂♂, 2 ♀♀ (including the ♀ described in the above re-description), Witu Forest, British East Africa (*the Sultan of Witu;* presented by the late W. S. Godfrey); 1 ♀, locality unknown.

The above list of localities shows that the present species occurs both in West and East Africa, so that it doubtless extends right across the continent, but as to whether it exists on the headwaters of the Congo, or at other intervening points, we have as yet no information. In West Africa the most northerly locality from which the species has been recorded is Bismarckburg, in the Hinterland of Togo, the approximate latitude of which is 8° 12′ N., about 10° 32′ further north than Witu, the most northerly locality on the east coast. The most southerly locality is somewhat vaguely represented by Mr. Hooke's specimen from "country south of Mashonaland."

Habits, etc.

It will be seen later on that, according to the concluding paragraph of Captain Crawshay's "Note on the 'Tse-Tse' Flies of the British Central Africa Protectorate" (see Chapter VII. Appendix B, p. 289), the specimens of this species taken at Kaporo did not bite; but this was doubtless due to the fact that they were captured at sunset, and not during the heat of the day.

In a letter dated 16.4.1898, forwarding the four specimens of *Glossina pallidipes*, and the single example of *Gl. fusca* already referred to, as well as a single specimen of *Gl. longipennis*, Corti, as mentioned below, the late Capt. A. J. Haslam, at that time Transport Officer to the Uganda Railway, wrote as follows about what he termed the "larger" Tsetse, a designation that under the circumstances must be taken to include both *Gl. fusca* and *Gl. longipennis*.—"The larger one . . . is the one found abundantly at Kiboko River (a very deadly fly district), and on the Sabaki River near its junction with the Tsavo River. This large kind is larger than the South African Tsetse. Its flight is typical, and like the other kinds it flies low—going for the bare legs of porters and the legs of animals. . . . I am not yet in a position to state whether the wings of the larger kind actually cross, as do those of the

* See below under "Habits, etc."

smaller kind, when sucking blood, but this I will soon be in a position to report upon. . . . I am as yet unable to say whether a different organism is harboured by these flies." *

Synonymy and Affinities.

In the year 1873 ("Entomologist," Vol. VI., p. 328) Walker sunk *Gl. fusca* as a synonym of *Gl. longipalpis*, Wied., with which of course it has nothing whatever to do. It is a perfectly good species, and with *Gl. longipennis*, Corti, to which it is very near akin, it forms a group which, by reason of the considerably larger size of the individuals, contrasts strongly with the other species of the genus at present known. The differences between *Glossina fusca* and *Gl. longipennis* will be dealt with below under the latter species.

* Captain Haslam's work was unfortunately not destined to be completed, as he lost his life three months after the above-quoted letter was written, while pursuing his investigations upon Tsetse-fly disease in British East Africa. I am indebted to the courtesy of his friend Dr. H. C. L. Scofield, of North Dulwich, for information relating to Captain Haslam's end. Dr. Scofield kindly forwarded to me for perusal letters received by him from Captain Cooper, 7th Dragoon Guards, and Dr. A. T. White, Medical Officer, Uganda Protectorate, who found and buried Captain Haslam's body, on July 21, 1898.

Captain Haslam was murdered by Mulukas (a tribe of the Wakikuyu) on July 17, 1898, near the Theka Theka River, Kenia district, British East Africa, while on an expedition in connection with his investigations upon Tsetse-fly disease. He was killed by a spear-wound through the back, and his body (much mutilated) was found four days later by Captain Cooper and Dr. White, who were returning from an expedition to punish the natives for an attack on Captain Cooper's camp. Captain Haslam's remains were interred, with military honours, close to the spot where they were found, but were afterwards taken into Kikuyu and buried by the side of the grave of Captain Nelson, who had travelled with Stanley. Of the results already achieved by Captain Haslam before his untimely death, Dr. White writes as follows: "I only hope that some means will be found of publishing his notes on the Fly disease, at which he had done so much valuable work. I met him for some time at Machakos, where we did a good deal of work together at the microscopic examination of the blood of the local Horse-flies, not the Tsetse, and one could not help being struck by the amount of work he had already done,—work of the very greatest value for the future of this country."

That Captain Haslam fully appreciated the possibility that the parasite of Nagana may be conveyed by blood-sucking flies other than *Glossina* is evident, and his discovery of *Trypanosoma* in a species of *Stomoxys* is alluded to in Chapter VII., Appendix E (p. 304). It is therefore with keen regret that I learn that Dr. White's hopes are vain, and that yet another name must be added to the roll of those martyrs to science who have perished and "have no memorial." In a letter to the author on June 4, 1902, Dr. Scofield wrote: "I have received further communications stating that the papers containing Captain Haslam's notes of his researches were hopelessly lost in the looting following his murder."

Glossina longipennis, Corti.

(Plate VII.)

Glossina longipennis, Corti, Ann. Mus. Civ. Genov, Serie 2ª, Vol. XV. (XXXV.), p. 138 (1895); Hough, Proc. Acad. Nat. Sci. Philadelphia, 1898, p. 172; Austen, Proc. Zool. Soc. Lond. 1900, p. 10.

♂, ♀.—Length, $10\frac{2}{3}$ to $11\frac{1}{3}$ millim. (5 to $5\frac{1}{3}$ lin.); length of wing, $11\frac{1}{4}$ to 12 millim. ($5\frac{1}{4}$ to $5\frac{3}{5}$ lin.); width of head in ♂, $3\frac{1}{2}$ millim. ($1\frac{3}{5}$ lin.), in ♀ $3\frac{1}{2}$ to $3\frac{2}{3}$ millim. ($1\frac{3}{5}$ to $1\frac{3}{4}$ lin.); width of front at vertex, in ♂ $\frac{3}{4}$ millim. ($\frac{2}{5}$ lin.), in ♀ just over 1 millim. ($\frac{1}{2}$ lin.); length of proboscis (palpi) beyond margin of buccal cavity, $2\frac{2}{3}$ millim. ($1\frac{1}{4}$ lin.).

Thorax isabella colour, with a narrow faint longitudinal stripe on each side of the median line, dying away behind the transverse suture before reaching the hind margin, and four sharply defined small dark brown oval spots, arranged in a parallelogram, two in front of and two behind the transverse suture; abdomen ochraceous-buff,† the longer hair at the base of the second segment entirely golden yellow, the third to the sixth segments inclusive each with a dark brown lunate mark on each side at the base, widely distant from the median line, but not extending quite into the basal angle; ocellar spot dark brown; proboscis bulb chrome yellow, with a sharply defined dark brown or reddish brown tip.*

Head.—Buff, posterior surface grayish; the spots at the base of the vertical bristles brown, but not united by a brown band; frontal stripe scarcely darker than the margins, the latter, as well as the face and facial pit, faintly shimmering whitish-yellow. *Ocellar spot* small, but conspicuous owing to its dark brown colour; ocelli small, the anterior ocellus of the same size as the other two ocelli. *Antennæ:* first two joints buff; second joint sometimes more or less brown on the inside; third joint brownish, the tip broader and with more prominent apex than is usually the case in *Gl. fusca;* arista buff, shorter than in *Gl. fusca*, second joint dark brown on under side only at extreme base. *Palpi* buff-yellow, not darker above, the tips brown. Bristles fringing the margin of the buccal cavity, below the facial angle fine, numerous, and golden yellow.

* Ridgway, "Nomenclature of Colors," Pl. III. Fig. 23.
† Ridgway, *Ibid.* Pl. V. Fig. 10.

Thorax.—Clothed with grayish dust, but when denuded sometimes appearing reddish on median area of dorsum; the two dark brown spots in front of the suture slightly further apart than the two behind it; an additional pair of fainter and somewhat more reddish-brown oval spots usually visible on the suture itself, one on each side of the ad-median stripes, and between them and the spots already mentioned; in addition to these marks there is usually a faint trace of a longitudinal stripe on each side (representing the inner arm of the curved stripe, as described for *Gl. palpalis*), between the two dark brown spots and the spot on the suture; indications of this stripe are usually confined to the neighbourhood of the humeral callus and the hind margin; there is also usually a tiny reddish-brown fleck in front of the suture, and between the two dark brown oval spots on each side; humeral callus with only a faint trace of a brownish blotch on its upper portion, Scutellum pale brownish, the margin and impressed median line buff.*

Abdomen.—The dark brown interrupted transverse bands, of the type seen in *Gl. morsitans*, are here much reduced (see Plate VII.); posterior angles of the third to the sixth segments inclusive clothed with whitish-gray dust.

Legs.—Buff, femora with faint dark patches on the outer side, and middle femora with a brownish blotch on under side near tip (as in *Gl. fusca*); only a very faint trace (often entirely wanting) of a darker ring on the hind tibiæ near the base; last joint and tip of penultimate joint of middle tarsi infuscated; last two joints of hind tarsi black. Row of bristles at base of front coxæ ochraceous; hair clothing front coxæ below golden-yellow.

Wings.—Brownish; veins pale tawny, with local infuscations, as in *Gl. fusca*. *Squamæ* not infuscated; fringe pale yellow, silky. *Halteres* yellowish-white.

The type of *Gl. longipennis*, Corti, is a ♂ in poor condition, which has evidently been kept in spirit prior to being pinned. The above description has, therefore, been prepared from a ♂ from Somaliland (*Th. Greenfield*), in the collection of the British Museum, and a ♀ from West Somaliland, 23–25. vi. 1895 (*C. V.*

* In two specimens (one of which is the type of the species) out of the seven examples of *Gl. longipennis* that I have been able to examine there is possibly a second dorso-central bristle, but if so it is so small as to be practically indistinguishable from the surrounding hairs; in none of the specimens can an intra-alar bristle be distinguished.

A. Peel), in the collection of the Oxford Museum; both of these specimens have been specially labelled.

Distribution of *Gl. longipennis*, Corti.

Of this species I have been able to examine a series of seven examples as follows:—

1 ♂ (type of the species), River Uelmal, Boran Galla Country, N.E. Africa, June, 1893 (*Capt. Vittorio Bottego*), lent by the Museo Civico di Storia Naturale di Genova, through the courtesy of Dr. R. Gestro; 1 ♀ (type of the above description of the ♀), West Somaliland, 23–25. vi. 1895 (*C. V. A. Peel*) [O.]; 3 ♂ ♂ (including type of above re-description of the ♂), 1 ♀, Somaliland, precise locality unknown (*Th. Greenfield*); 1 ♂, Uganda Railway, British East Africa—? Kiboko River, or Sabaki River near its junction with the Tsavo River, 1898 (*Vet.-Capt. A. J. Haslam*).

The above list of localities shows that the present species is the Tsetse-fly of Somaliland and the adjacent regions, but that its range overlaps that of *Gl. fusca*, Walk., somewhere in the vicinity of the Sabaki River. A field-note by Mr. Peel attached to his specimen mentioned above says: "Fly-belt sharply defined from Biermuddo to Boholo Deno."

Habits, etc.

See the remarks quoted above (pp. 99–100) under *Gl. fusca*, from Capt. Haslam's letter of 16. 4. 1898.

It will have been observed that, of the seven specimens of *Gl. longipennis* examined, all but two are males. One of the male specimens collected and presented by Mr. Greenfield was evidently taken in the act of sucking, since its abdomen is swollen and distorted owing to its containing decomposed blood, while there is a globule of coagulated blood at the tip of the proboscis.

Synonymy and Affinities.

Glossina longipennis, Corti, is perhaps the best and most easily characterised species of the genus. A year before the species was actually described I had noted the specimens presented to the British Museum by Mr. Greenfield as a new species allied to *Gl. fusca*, Walk. It is unfortunate that at the end of

his original description Corti (*loc. cit.*, p. 139) states that the species is allied to *Gl. tachinoides*, Westw. (= *Gl. palpalis*, R.-Desv., var. *tachinoides*, Westw.), to which of course it is in reality by no means closely related. As already stated in dealing with *Gl. fusca*, Walk., the latter species, with the one under discussion, "forms a group which, by reason of the considerably larger size of the individuals, contrasts strongly with the other species of the genus at present known."

Apart from all other characters, *Glossina longipennis* is readily distinguished from *Gl. fusca* by the ocellar spot being dark brown and therefore very conspicuous, and by the presence of the four dark brown oval spots on the dorsum of the thorax. These dark brown spots are perhaps remnants of the dark patches enclosed in the curved stripe in the complete scheme of thoracic markings in the genus *Glossina*, as described above in the case of *Gl. palpalis;* but they are so much darker than the remaining very faint and *vestigial* markings on the dorsum of the thorax in *Gl. longipennis* that they appear as altogether independent markings.

It must be observed that the wings in the present species are not noticeably longer in proportion to the size of the body than are those of any other species of *Glossina*. On the other hand, the *proboscis* (*i.e.*, palpi and proboscis) is remarkably short—*actually* considerably shorter than in *Gl. fusca*, and *relatively* shorter than in any other species of the genus,* so that *brevirostris* would have been a much more appropriate designation.

Lastly, it should be noted that in both sexes of *Gl. longipennis* the *front* is considerably broader than in *Gl. fusca*.

* It says much for the discernment of the late Captain A. J. Haslam, whose untimely death cannot be too greatly deplored, that he should have noticed this in the field. As has already been mentioned, Captain Haslam, while acting as Transport Officer to the Uganda Railway in 1898, collected and forwarded to the British Museum specimens of *Glossina pallidipes fusca*, and *longipennis*, and it is therefore to *Gl. pallidipes* and *Gl. longipennis* that the following observation, taken from his letter of 16.4.1898, must be held to apply: "It is seen that the proboscis of the smaller ones is larger in proportion to the body than the proboscis of the larger flies is to their bodies."

CHAPTER V.

THE MOUTH-PARTS OF GLOSSINA AND STOMOXYS.

(Plates VIII. and IX.).

By Dr. H. J. Hansen (Copenhagen).

The *Glossina* material investigated by me consisted of four specimens belonging to three species, viz., a male and female of *Gl. pallidipes*, Austen, and males of *Gl. morsitans*, Westw., and *Gl. fusca*, Walk.* All the specimens were dried; the heads I boiled in water and examined as well as possible, after which three of them were cleaned in a cold solution of caustic potash, so that the chitin could be better studied. For comparison I have also examined some spirit specimens of the common European blood-sucking form *Stomoxys calcitrans*, L., and one dried specimen of an African species of the same genus.† After the examination of *St. calcitrans* I was able to find nearly all the same muscles in the boiled specimens of *Glossina*, but it is of course impossible to discover and study such organs as small glands, nerves, etc., in specimens which have been preserved in a dried condition. In the following pages I furnish a description of the essential features of the external and internal mouth-parts, and attempt to show how the animals bite and pump the blood into the alimentary canal. Neither the very short time (nine days) available for my investigation, nor the quality of the material of *Glossina*, permitted me to make a more special study

* The labels attached to the specimens were as follows:—*Gl. pallidipes*, Austen, ♂: "Kilima-Njaro, F. J. Jackson"; *Gl. pallidipes*, Austen, ♀: "Witu Forest, 1895, Sultan of Witu, per W. S. Godfrey"; *Gl. morsitans*, Westw. ♂: "Beira Railway, Lower Pungwe River, Portuguese East Africa, Oct. 1897, G. A. K. Marshall,—'Flew into railway carriage at night attracted by light'"; *Gl. fusca*, Walk.: "Witu Forest, 1895, Sultan Witu, per W. S. Godfrey."

† This specimen bears the label; "Pemba Island, East Africa, 26. viii. 1899, D. R. O'Sullivan Beare."

of minute structural features, and a very detailed description would scarcely be suitable for the present work.*

A. External Mouth-parts in *Glossina*.

I was unable to discover the slightest difference between these parts in the male and female of *Gl. pallidipes*, and the two other species did not present any difference from the first-named form worth mentioning.

The *maxillary palpi* (Fig. 1, *p*)† are somewhat longer than the height of the head, horizontally projecting, with a deep longitudinal groove on the side turned towards the plane of symmetry; they enclose the major part of the proboscis, of which only an inflated basal portion (*l*) is seen on the under side of the head. The proboscis is rather thick at the base, but nearly three-fourths of its length are proportionately exceedingly slender; it reaches almost to the end of the palpi, and is feebly curved, with the concavity beneath. It consists of three parts (Fig. 2); the *upper lip* or *labrum* (*a*), the *hypopharynx* (*b*), and the *lower lip* or *labium* (*c*).

* So far as I am aware, the mouth-parts of *Glossina* have never been investigated before. Both *Glossina* and *Stomoxys* are fairly near allies of the European blow-flies (*Calliphora erythrocephala*, Mg. and *C. vomitoria*, L.), and the mouth-parts of *Calliphora* have been carefully studied by K. Kraepelin (*Zeitschr. f. wissensch. Zool.* 39 Bd. 1883, pp. 683–719, Taf. XL.–XLI.) and B. T. Lowne ("The Anatomy and Physiology of the Blow-Fly." London, 1870); a second and greatly enlarged edition of Lowne's work was published in 1890–95: "The Anatomy, Physiology, Morphology, and Development of the Blow-Fly (Calliphora erythrocephala)." By B. T. Lowne. 2 Vols. (London: R. H. Porter), 1890–95. My description of the mouth-parts of *Glossina* and *Stomoxys* is not so detailed as the accounts by Lowne and Kraepelin of those of *Calliphora*, and I disagree with these authors as to some of their interpretations of muscles, etc.; but I have deemed it advisable to omit special references to their statements as well as critical remarks on some of their opinions. From earlier investigations I am well acquainted with the mouth-parts in several families of Diptera (H. J. Hansen: "Fabrica Oris Dipterorum, I. (Tabanidæ, Bombyliidæ, Asilidæ, Thereva, Mydas, Apiocera);" *Naturhist. Tidsskrift*, 3. Række, B. 14, 1884, pp. 1–220, Tab. I.–V.);—otherwise I should not have ventured to examine nothing but dried specimens of *Glossina*.—I may add that F. Meinert, in his work entitled "Trophi Dipterorum" (4to, Kjøbenhavn, 1881), devotes two-thirds of a page and three figures to the mouth-parts of *Stomoxys*; this is the only modern note on the proboscis in that genus. Meinert observes (p. 65) that the labella of *Stomoxys* have "rows of teeth and chitinous blades," which form "a saw with several rows of strong, sharp teeth, with which this Dipteron is able to saw a hole in the skin of Mammals;" but his drawing (Tab. V. fig. 24) of the structure in question is very incomplete (the strong teeth are wanting) and incorrect.

† The references to figures in this Chapter all relate to Plates VIII. and IX.—E. E. A.

The *labrum* (Fig. 2, *a*) is somewhat shorter than the labium, reaching to a point situated at the beginning of the distal ninth part of the last-named organ. It is narrow, though a little broader towards the base; in the natural condition the lateral margins can be seen to turn downwards, and even a little inwards, so that the labrum forms about two-thirds of a tube (compare the diagrammatic transverse section, Fig. 6); the lateral walls are flexible, the dorsal wall is a little thicker. In Fig. 3 the labrum is shown from below and rather flattened; the median part (*p*), of a darker tint in the figure, is the median portion of the wall of the concavity on the lower side—the so-called epipharyngeal plate—which is moderately thick; no muscle is found in the cavity between this plate and the dorsal wall. Fig. 4 shows that this thickening in the lower wall terminates before the distal end of the labrum, which is in the shape of a triangular and rather feebly chitinised plate. In Fig. 5, the basal part is seen from below; the lateral margins (*m*) are bent a little inwards; the small rings (*s*) are apertures in the epipharyngeal plate (*p*), and from each aperture proceeds a hair which is exceedingly fine (so much so that it was impossible to show it in the figure) and proportionately long; somewhat similar structures have been discovered in other Diptera, and considered as organs of taste (compare the labrum of *Stomoxys*). On the basal part these structures are numerous, but on the remainder of the labrum there are very few of them (two are shown in Fig. 4). The inner processes (Fig. 2, *i*) from the base of the labrum, and the muscles to its base and to the processes, are as in *Stomoxys* (see below).

The *hypopharynx* (Fig. 2, *b*) is somewhat longer than the labrum, and a little shorter than the labium, reaching slightly beyond the base of the labella. As is usually the case in Diptera, it is an exceedingly slender cylindrical tube, being the outlet from the thoracic salivary glands; its distal extremity is membranous (Fig. 7).

The *labium* (Fig. 2, *c*, and Fig. 12, *e*) is very interesting. The basal fourth is thick and inflated, considerably broader than deep, with a median, rather broad dorsal groove; its distal three-fourths are very slender, nearly equal in depth throughout, and somewhat compressed. This slender part has a very deep median dorsal groove; in reality it is strongly depressed, and the broad lateral thin parts are bent upwards and a little inwards above, thus forming the groove between them; or, more correctly,

a long tube is formed, with a slit on the upper side (compare Fig. 8, which is a diagrammatic transverse section of the labium near the middle). The labium consists of two segments and the labella, but without a comparison with *Stomoxys*, *Musca*, and *Asilus*, it would be impossible to discern these elements in *Glossina*. The second segment and the labella (Fig. 2, *c* and *f*) are together only about one-fifteenth of the length of the labium. The sides of the labella, of the second segment, and of the most distal part of the first segment are brownish and rather firmly chitinised, so that the different sections are not easily distinguished one from another; a narrow band at the upper margin and an exceedingly short terminal portion of the labella are more or less membranous; the labella (Fig. 2, *f*) have a dark brown or black area below just behind the cleft between them, and the second segment has a pair of small, rather dark, oblique plates on the under side (Fig. 2, *e*, and Fig. 9, *b*). Seen from the side the labella are rounded at the end; seen from below (Fig. 9, *c*) the cleft between them is sometimes narrow and triangular, and sometimes the labella lie close together.

The inflated basal part of the first segment is somewhat strongly chitinised on the sides and below, while the slender part of the same segment is firmly chitinised below, with moderately thin lateral walls. The bottom of the median groove is a rather thick plate, which begins just below the base of the labrum, and continues nearly to the end of the labium; in the most distal portion of the first segment, in the second segment, and on the proximal part of the inner side of the labella this plate is very strong, and covers not only the bottom, but the sides of the deep groove, almost to its upper margin. Fig. 10 represents the right labellum seen from the inner side; *a* is the outer ventral wall (the black spot) divided in the median line; *c* the plate in the bottom of the groove divided in the same way; *d* is the lateral part of this plate, and *e* its incurved upper margin. The same figure shows that the inner wall of the free part of the labellum is sheathed with three plates (*g*), which are strongly chitinised, and over the major portion of their surface adorned with a considerable number of transverse rows of exceedingly small teeth, thus presenting a certain resemblance to a rasp. All these plates are prolongations of the plate in the groove, but the upper and lower ones are narrowed basally and marked off at the base by a suture allowing a slight degree of mobility. The lateral margins of all three plates are finely serrated (the number

of the teeth being identical with that of the transverse rows of teeth), and lie close together. The upper distal angle of the upper plate and the lower distal angle of the lower plate are each produced into a triangular tooth (*h* and *i*); at the distal end of the plates are firmly inserted four very large teeth (*k*), two on the median and one on each of the other plates, and these six teeth are directed towards the distal end of the labella. The skin between the insertion of the submedian teeth and the end of the labium is membranous and scaly (*l*), and at the upper margin bears a number of short, stiff setæ (*m*) instead of scales.

I am inclined to think that a portion of membranous skin has been invaginated from the end of the labella, and that in material preserved in spirit, or at any rate in fresh specimens, the labella would sometimes be found with the membrane alluded to evaginated and easily visible. This assumption is based on the fact that with transmitted light four very long chitinous rods are easily seen between the outer and the inner walls of the terminal portion of the labellum; in Fig. 11 this portion of the right labellum has been drawn as seen from the outer side, and the rods are indicated by dotted lines (*d*). Each rod is very long, and nearly cylindrical, with the distal end rounded, and is articulated to a somewhat short and rather thicker cylindrical foot. I am unable to decide as to what the function of these rods may be; they are hollow, but I could not discover any aperture at the end, and if they were ducts from glands a distal aperture must exist. I am therefore most inclined to believe that these rods are sense organs. They must be inserted in membranous skin, which is invaginated in the dried specimens seen by me.

The outer side of the distal half of the labella exhibits a small number of holes in which setæ have been inserted; in two of my species these setæ had been broken off near the base, but in *Gl. fusca* they were present as moderately short stiff spines, directed outwards and partly backwards. In the last-named species I have also found four very small, clear rods arranged along the distal end of the labellum; these rods are certainly sense organs.

In *Tabanus*, *Asilus*, and *Calliphora* the labium contains three pairs of muscles: in *Glossina* I could distinguish two pairs with absolute certainty, and they fill up the basal inflated portion of the organ. One pair proceeds from the sides of the labium in an oblique direction and forwards to the margin of the plate

situated in the bottom of the groove. The second pair is very large; each of its muscles terminates in a tendon, which is very strong and runs from the distal end of the inflated portion to the outer wall of the labellum. I am unable to decide whether the slender portion of the first segment of the labium contains a third pair of muscles, like those in *Stomoxys*, described later on.

The hypopharynx is firmly united, or one might say fused, with the proximal end of the plate in the groove of the labium, and a little more distally it is connected with the base of the lower wall of the labrum (compare Fig. 22 of *Stomoxys*). The hypopharynx being a direct prolongation of the posterior wall, and the epipharyngeal plate (the lower side of the labrum) the direct prolongation of the anterior wall of the pharynx, the opening of the mouth may be said to be situated just at the connection between the hypopharynx and the labrum.

B. External Mouth-parts in *Stomoxys*.

There is no difference between these organs in the male and female; furthermore, the differences observed between the mouth-parts in *St. calcitrans* and the African species are slight. The following description is based essentially on *St. calcitrans*.

The *proboscis* is somewhat longer than the height of the head, horizontally projecting (Fig. 15), but not covered by the palpi, which are very slender, and cylindrical, and in the species examined by me are scarcely one-third or not a quarter as long as the proboscis. This consists of the same parts as in *Glossina*.

The *labrum* (Fig. 16, *a*) reaches nearly to the base of the labella. It is more strongly chitinised than in *Glossina* and almost of the same shape (Fig. 17), but the lateral walls are more incurved below, so that the labrum constitutes a tube with a moderately broad slit along the lower side. The apical portion (Fig. 18) is oblong triangular, subacute, and rather firmly chitinised. Not far from the end some sense organs (Fig. 18, *s*) are observed; in the sub-basal portion of the labrum such organs are rather numerous, and some are found in the intermediate portion. Each organ bears a moderately short and clear hair, and the ganglion at its base is often easily observed. To each of the lateral basal angles is firmly attached a strong chitinous rod or apodeme (Fig. 17, *b*), which is rather long and proceeds upwards in the head (Fig. 21, *h*); to its free end is attached a fairly strong muscle, which runs to the distal solid end of the pharynx

(Fig. 21, m^3; Fig. 17, *c*), and by the contraction of this pair of muscles the distal end of the labrum is raised. From the base of the upper wall of the labrum a muscle (Fig. 17, *e*; Fig. 21, m^1) runs upwards to the frontal part of the lateral wings of the pharynx; the contraction of this muscle will press the distal part of the labrum downwards. For the secondary results of the contraction of these muscles, and as to a third pair of muscles (Fig. 17, *d*; Fig. 21, m^2) attached near the base of the above-mentioned apodemes the reader is referred to the section on the internal mouth-organs.

The *hypopharynx* (Fig. 16, *b*) is as long as the labrum; it is a thin cylindrical tube, with the apical part membranous (Fig. 19), as in *Glossina*.

The *labium* (Fig. 16, *c*) differs considerably from that of *Glossina*. Nearly the whole of the basal half is somewhat swollen, but to a much lesser degree than in the other genus, and its distal portion is considerably less slender; the dorsal groove is in the distal half proportionately less deep than in *Glossina*. The labella are slightly higher than the second and than the distal part of the first segment; the labella and the second segment together occupy about one-sixth of the length of the whole organ. The labella have on their outer side near the end, and at the lower margin, a row of partly rather long, partly short setæ. The inner side of the labella is exceedingly interesting (Fig. 20). As in *Glossina*, the plate (*c*) in the groove is distally very strong, and occupies not only the bottom but the major part of the sides; its end is obliquely truncated, and on each labellum a very high plate (*d*) is attached to the end by a well-developed articulation. From the basal part of this labellar plate five enormous teeth (*e*) proceed forwards and downwards. These teeth, which are arranged in a curved row, are firmly anchylosed to the plate, very stout, a little more to a little less than two and a half times longer than broad, distally triangular and subacute. The three middle ones are distally irregularly serrated along both margins, and possess in addition small secondary processes near one margin; the upper tooth is serrated distally along the upper and the lower tooth along the lower margin. The area between these teeth and the membranous distal margin of the labellum is occupied by two rows of large, elongate, rather thin and very sharp chitinous blades (*f*), of about the same shape as the blade of a knife, and directed the same way as the large teeth. A little way inside the distal

margin of the labellum a number of hairs are inserted, some of which at least are branched. Below the terminal portion of each of the big teeth one or two dark-coloured, rather long chitinous rods (*g*) are inserted; they are sub-cylindrical, slightly curved, and hollow, and seem to possess an aperture on the distal obtuse end.

The labium contains three pairs of muscles. The first pair is lamellar, with short fibres, and proceeds from the outer lateral wall obliquely to the margin of the plate in the bottom of the groove; these muscles occupy the greater part of the length of the labium. The second pair is very large, filling most of the lumen of the basal third of the labium; each muscle terminates in a very strong tendon, which is attached to the outer wall of the labellum. The third pair is, so far as I was able to see, very different from that in *Calliphora* and *Tabanus;* the fibres are very short, proceeding from the ventral side of the plate in the groove obliquely forwards and downwards to the ventral wall of the first segment, at least in its distal half.

The hypopharynx, labrum, and labium are attached to each other at their base much as in *Glossina*; but the attachment of the hypopharynx to the labium seems to be less solid than in that genus.

C. Mode of Action of the External Mouth-parts in *Glossina* and *Stomoxys*.

In both genera, the tube through which the blood of the animal on which the fly may be feeding passes to the pharynx, is constituted by the labium and the labrum together. The labrum lies within the deep dorsal groove of the labium, closing it above and also forming the inner lateral walls of the tube; beyond the end of the labrum the sub-membranous margins of the labium touch or perhaps cover each other above; in specimens of *Stomoxys* preserved in spirit, I have seen the margins of the labium in contact for half the length of the proboscis. The hypopharynx is completely enclosed in the tube mentioned. In both genera a short terminal portion of the hypopharynx is entirely membranous, and this organ is consequently useless for the stabbing of victims; the labrum is somewhat shorter than the labium, and in *Glossina* at any rate its extremity is not strong enough for piercing. The insects belonging to both genera perform this operation by means of the armature of the

inner side of the labella, and the extremely strong muscles, the tendons of which are attached to the outer wall of the labella, must be the chief factors in the necessary movements. By the contraction of these muscles the inner sides of the labella are turned so much outwards that their teeth are able to act upon the skin of the victim; I am unable to decide whether the muscles described above as the third pair in the labium of *Stomoxys* can assist by pushing the plate in the groove outwards, and thereby affecting the plates on the inner side of the labella in a similar manner. In *Glossina* the teeth are inserted rather near the end of the labella, and it must be these six pairs of teeth which are at least the chief instruments in piercing a hole. But I am bound to confess that I can form no opinion as to the significance of the three pairs of rasp-shaped plates—whether they assist during the piercing or are useful in another respect. In *Stomoxys* the five strong teeth are situated near the base of the labella; but in this insect the labella are more movable, and can be turned outwards so that the teeth can act on the skin of a victim.* The blades in the two rows are very sharp, but rather thin; they probably have an accessory function in the act of piercing.

It is, in my opinion, highly probable that the hole produced by *Stomoxys* is not very deep, the labella being proportionately rather thick, and the essential teeth being placed so far from the end that the labella must be greatly shortened and much turned outwards when the fly bites. But in *Glossina* the labella are very slender, and more strongly chitinised on the outer side, with their teeth near the end, and it is therefore probable that the proboscis can be sunk rather deeply in thick skin. The saliva is introduced into the wound from the end of the hypopharynx, and—as in the case of mosquitoes (*Culex*, *Anopheles*)—is certainly mixed with the blood which is to be pumped through the proboscis.

D. Lower Portion of the Head in Both Genera.

As in the blow-fly and the common house-fly, the lower part of the head, between the outer mouth-parts and the firmly chitinised portion of the head, is completely membranous and can be forced

* In a specimen of *Stomoxys* preserved in spirit I found the labella turned outwards to such an extent that the big teeth occupied their distal extremity, and were directed almost vertically to the sides, and only slightly downwards.

downwards so as to constitute a cone, with the outer mouth-parts on the end (Fig. 16): this cone is evidently somewhat longer in *Stomoxys* than in *Glossina*. Fig. 12 represents the median part of the posterior side of the head and the labium (*e*) in *Glossina*, with the long membrane (*d*) between both; *c* is the occipital foramen, *a* the firmly chitinised part. It will be seen that there is a deep median incision, which is membranous, and surrounded at the sides by the firm chitin which borders the eyes below; the labium can be pulled upwards, so that its basal part occupies this median area, the membrane being invaginated and folded. On the front side of the head the *epistoma*, which is the median area below the transverse prominence under the antennæ, is membranous in *Glossina*, with the exception of an upper transverse area, which is coalesced with the wings of the pharynx (see below). In *Stomoxys* the epistoma shows essentially the same structure, but the sub-basal transverse solid chitin is short, and from it two parallel dark strips run downwards (Fig. 16, *i*) nearly to the base of the maxillary palpi. The muscles which effect the protrusion and retraction of the membranous cone are mentioned below. The maxillary palpi (Fig. 16, *g*) are inserted on the anterior side of the cone, a little below its upper margin. No other vestige of the maxillæ and no rudiment of mandibles can be discovered; but in *Stomoxys* I found at the base of each palpus a very small curved chitinous strip (Fig. 16, *h*), movably united with the palpus. Whether this strip is a rudiment of the maxilla I cannot say.

E. The Internal Mouth-parts of *Glossina* and *Stomoxys*, and their Mode of Action.

From the tube constituted by the external mouth-parts the blood is conducted into the pharynx, which is a very large and complicated organ. In the natural position and seen from the side (Fig. 21) it is nearly vertical, but slopes slightly forwards. It is obliquely triangular, with the two upper posterior lateral angles produced into a moderately short (*Glossina*, Fig. 2, *m*) or a very long process (*Stomoxys*, Fig. 21); in *Stomoxys* the two upper anterior angles are also produced. Fig. 13 represents the pharynx of *Glossina* seen from behind, together with the basal part of the œsophagus (*d*), and a small anterior separate part (*c*) between the pharynx itself and the external mouth-parts. Fig. 14 is a diagrammatic section of the same pharynx at its thickest point:

it will be seen that posteriorly it has two walls, with a narrow—or in the resting position with no—space between them, and the anterior of these walls is the thinner. The lateral wall (*c*) is thick, and anteriorly coalesced with the thickened part of the epistoma (*d*). In reality the pharynx is a part of the œsophagus, which has been firmly chitinised, widened, and strongly depressed, with the anterior wall slightly concave and the lateral margins produced into very broad wings (*b*), which turn forward and coalesce with the epistoma. The large space between the lateral wings, the anterior of the two posterior walls and the firm part of the epistoma is nearly filled with enormous muscles (*m*); in the distal part of the pharynx the fibres run very obliquely upwards and forwards to the epistoma (Fig. 21); in the upper part of the pharynx they run horizontally, or in front even a little downwards (Fig. 21). The contraction of these muscles produces a space between the two posterior walls of the pharynx, and the whole organ is a pumping-engine. It must be supposed that the distal fibres of the muscle contract, raising the corresponding part of the front wall, and thus producing a space void of air into which the fluid is sucked from the tube formed by the external mouth-parts. Next, the more proximal fibres contract, while the most distal ones relax, and the result of a successive contraction of all the fibres from below upwards, the lower ones relaxing simultaneously with the contraction of the upper ones, and so on, will force the blood of the victim upwards through the pharynx into the œsophagus itself, and also produce a suction from the wound at the end of the labella. The œsophagus itself (Fig. 21, *l*) is a membranous tube (having in *Glossina* a small sub-basal dorsal plate, Fig. 13, *e*), which is at first as broad as the pharynx (Fig. 13), then narrower, and is bent backwards in a curve to the occipital foramen (Fig. 21). Between the lower end of the solid pharynx and the attachment of the labrum to the hypopharynx is found a tube, which in *Glossina* is rather short and wide, firmly chitinised in the posterior half (Fig. 13, *c*) and membranous in front. In *Stomoxys* it is longer and narrower, with irregular sub-circular linear thickenings in the wall (Fig. 22, *g*).

From the postero-superior process of the pharynx a strong muscle (Fig. 21, m^7) proceeds downwards to the cheek at the side of the epistoma. The thickened part of the epistoma, with which the wings of the pharynx are coalesced, is united with the solid chitin below the antennæ by a narrow transverse membranous

strip. When the pair of muscles referred to (m^7) are contracted, this strip functions as a hinge around which the pharynx moves in a downward direction, and the result is that the lower end of the pharynx, which by its apical tube (Fig. 21, *k*) is united with the base of the external mouth-parts, is forced downwards, pulling the external mouth-parts in the same direction and extending the membranous cone between these mouth-parts and the firm chitin of the head. The cone is retracted by at least three pairs of muscles. One pair (Fig. 21, m^5) is inserted on its posterior wall below the firm chitin, and proceeds upwards to a spot outside the occipital foramen; the second pair of muscles (m^4) proceeds upwards from the proximal end of the lower wall of the labium to the firm chitin on the posterior side of the head; the third pair (m^2) runs from the sub-apical part of the apodemes of the labium upwards and backwards to the posterior side of the head outside the occipital foramen. Probably a fourth muscle (Fig. 21, m^1), proceeding from the proximal end of the upper wall of the labrum to the anterior margin of the pharyngeal wings, may also act as a retractor of the membranous cone, and also as a depressor of the labrum, as mentioned above. That the three first-mentioned pairs can act as retractors of the cone is certain, but I must confess that I do not know whether they, or at least some of them, have some other function in addition. The muscles (Fig. 21, m^3) from the free end of the apodemes of the labrum to the lower end of the pharynx can certainly not only act as mentioned above, viz. raise the distal end of the labrum, but also assist (m^7) by the evagination of the membranous cone.

It has been mentioned above that the hypopharynx forms the outlet for the saliva from the glands in the thorax. The hypopharynx (Fig. 22, *c*) is perforated near its base on the under side, and from this aperture begins the free salivary duct (*h*), which runs upwards along the posterior side of the most distal part of the pharynx, and then (*i*) turns in a more backward direction to the occipital foramen. Just behind the sub-apical solid part of the pharynx the duct is dilated, and in the normal condition depressed into a sort of oval disk, with the anterior wall a little concave and the posterior convex. (In the specimen drawn in Fig. 22 this organ, *k*, was unusually thick, the anterior wall being raised.) From the anterior wall proceeds a pair of very thin and long muscles (Fig. 22, *m*; Fig. 21, m^8), the other extremity of which is attached to the posterior surface of the

pharynx near its upper end. The function of the dilatation of the salivary duct would seem to be to retain the salivary secretion. When the muscles referred to contract the anterior and posterior walls are separated (as in Fig. 22), and the passage is open. I can scarcely think that this organ acts as a pumping mechanism or syringe.

In this chapter all essential chitinous structural features and all the muscles belonging to the mouth-parts have been mentioned, so that the main points of the functions of the different organs can be understood. As already pointed out, the labella of *Glossina* especially need further study (with high magnifying power), which should be carried out on fresh material, or at least on well-preserved spirit specimens. Moreover, the depth to which these flies bury the proboscis in the skin of their victims should be observed, as also the time occupied in biting, etc.*

Explanation of the Figures (Plates VIII. and IX.).

The camera lucida was used for all the drawings, with the exception of the three diagrammatic sections of mouth-parts in *Glossina*. Some of the figures have been drawn as seen by transmitted light, and in these the thin-skinned parts are light-greyish, the solid parts dark; when a figure has been drawn in this way, the fact is specially mentioned below. The other figures (the diagrams excepted) have been shaded in accordance with the shape of the parts: the membranous parts are light greyish, while on the firm chitin dark shading is opposed to white.

Fig. 1.—Head of *Glossina morsitans*, Westw., ♂, × 11: *l*, basal inflated part of the labium; *p*, palpus.

Fig. 2.—External mouth-parts and pharynx of *Glossina morsitans*, Westw., ♂, seen from the side, × rather less than 21: *a*, labrum; *b*, hypopharynx; *c*, labium; *d*, its first segment; *e*, its second segment; *f*, labellum; *g*, basal part of the left maxillary palpus; *h*, anterior wall of the membranous cone; *i*, left apodeme of the labrum: *k*, posterior wall of the membranous cone; *l*, pharynx; *m*, its upper process; *n*, solid part

* According to M. Édouard Foà [135], when the Tsetse bites the proboscis "disappears completely in the flesh," while Lieut.-Col. Bruce writes (*vide* Chapter VII., Appendix A, p. 274):—"The act of feeding is remarkably quick. From the moment of settling on the animal until the fly is fully blown out with blood is often as little as 20 to 30 seconds," —E. E. A.

of the epistoma coalesced with the pharynx; *o*, tube between the pharynx itself and the labrum-hypopharynx; *p*, dilatation on the salivary duct; *q*, muscle attached to this dilatation; *r*, upper part of the salivary duct.

Fig. 3.—Labrum of *Glossina pallidipes*, Austen, ♀, seen from below and drawn by transmitted light, in a rather flattened condition; × 14: *p*, the plate in the lower wall.

Fig. 4.—Distal part of the labrum shown in fig. 3, seen from below and drawn by transmitted light; × 46: *p*, the plate in the lower wall; *s*, sensory organ.

Fig. 5.—Basal part of the labrum shown in fig. 3, seen from below; × 46: *m*, marginal part turned a little inwards; *p*, plate in the lower wall; *s*, sensory organ.

Fig. 6.—Diagrammatic section through the middle of the labrum of *Glossina*; *p*, plate in the lower wall.

Fig. 7.—Distal part of the hypopharynx of *Glossina pallidipes*, Austen, ♀; × 100: *a*, membranous apical portion.

Fig. 8.—Diagrammatic section through the middle of the labium of *Glossina*; *p*, plate in the wall of the groove.

Fig. 9.—Distal part of the labium of *Glossina pallidipes*, Austen, ♀, seen from below; × 100: *a*, terminal part of first segment; *b*, plate of the second segment; *c*, labella.

Fig. 10.—Right labellum of *Glossina pallidipes*, Austen, ♀, from the inner side; × 390: *a*, ventral outer wall, divided longitudinally; *b*, space between the outer ventral wall and the plate in the groove; *c*, the plate in the groove divided longitudinally; *d*, lateral part of this plate; *e*, upper part of the same plate bent a little inwards; *f*, upper sub-membranous margin of the labellum; *g*, the rasp-like plates; *h*, tooth on the distal upper margin of the upper rasp-like plate; *i*, tooth on the distal lower margin of the lower rasp-like plate; *k*, the large teeth, anchylosed to the end of the three plates; *l*, membranous scaly skin; *m*, setæ on the membranous skin; *n*, terminal portion of two of the long chitinous rods (? sense-organs).

Fig. 11.—Distal part of the labellum shown in the preceding figure, and seen from the outer side; × 390: *a*, lower margin; *b*, upper membranous margin, with rows of exceedingly small spinules; *c*, membranous skin; *d*, long chitinous rods, seen through the outer wall; *e*, insertions of hairs or spines, which have been broken off.

Fig. 12.—Lower median part of the posterior side of the head of *Glossina pallidipes*, Austen, ♀, with the labium in an exserted condition, seen from behind; × not quite 12: *a*, solid chitin on the posterior side of the head; *b*, solid chitin of the cheek; *c*, occipital foramen; *d*, membrane between the head and the labium; *e*, labium.

Fig. 13.—Pharynx of *Glossina pallidipes*, Austen, ♀, from behind; × 19: *a*, posterior wall of the pharynx; *b*, one of its lateral wings; *c*, plate in the portion between the pharynx itself and the hypopharynx; *d*, basal part of the œsophagus; *e*, small plate in the upper wall of the œsophagus.

Fig. 14.—Diagrammatic transverse section through the pharynx of *Glossina*; *a*, posterior wall of the pharynx; *b*, its anterior wall; *c*, its lateral wing; *d*, solid plate in the epistoma; *e*, pumping muscles.

Fig. 15.—Head of *Stomoxys* sp., ♀, from Pemba Island, East Africa; × 12: *l*, labium; *p*, maxillary palpus.

Fig. 16.—Outer mouth-parts, in an exserted condition, of *Stomoxys calcitrans*, L., ♂ (from Denmark); × 19: *a*, labrum; *b*, hypopharynx; *c*, labium; *d*, exserted membranous cone between the outer mouth-parts and the solid chitin of the head; *e*, apodeme of the labrum seen through the skin; *f*, firm chitin of the head; *g*, maxillary palpus; *h*, very small solid plate at the base of the palpus (? rudiment of the maxilla); *i*, solid vertical sub-median strip in the epistoma.

Fig. 17.—Labrum (with its apodemes) of *Stomoxys calcitrans*, L., ♂, from below; × 19: *a*, median longitudinal groove; *b*, strong chitinous rod, or apodeme; *c*, muscle from the free end of this apodeme, to the lower end of the solid pharynx; *d*, muscle from the apodeme to the posterior side of the head; *e*, muscle from the base of the upper wall of the pharynx to the anterior margin of the pharyngeal wings. (The entire length of the two last-named pairs of muscles is not drawn.)

Fig. 18.—Distal part of the labrum shown in the preceding figure, from below; × 120: *a*, lower margin of the labrum turned inwards; *b*, the median groove; *c*, sensory organ.

Fig. 19.—Distal part of the hypopharynx of *Stomoxys calcitrans*, L., ♂, from the side; × 120: *a*, membranous apical portion.

Fig. 20.—Right labellum of *Stomoxys calcitrans*, L., ♂, from the inner side: × 230: *a*, lower wall divided longitudinally; *b*, sub-membranous upper margin; *c*, the plate in the bottom and on the sides of the median groove; *d*, plate on the inner side of the labellum; *e*, very strong tooth anchylosed to the plate of the labellum; *f*, elongate chitinous blades; *g*, chitinous rods; *h*, setæ on the outer side near the terminal margin.

Fig. 21.—Vertical section, a little to one side of the plane of symmetry, through the lower part of the head of *Stomoxys calcitrans*, L., ♂; × 27; slightly diagrammatic: *a*, basal part of the proboscis, from the outer side; *b*, anterior wall of the membranous cone; *c*, maxillary palpus; *d*, oblique membranous part of the epistoma; *e*, section through the solid chitin just outside the epistoma; *f*, posterior wall of the membranous cone; *g*, section through the solid chitin outside the occipital foramen: *h*, left apodeme of the labrum; *i*, pharynx; *k*, tube from the lower end of the solid pharynx to the labrum-hypopharynx; *l*, œsophagus; m^1, muscle from the upper wall of the labrum to the anterior margin of the pharyngeal wing; m^2, muscle from the apodeme of the labrum to the posterior side of the head; m^3, muscle from the free end of the apodeme of the labrum to the lower end of the pharynx itself; m^4, muscle from the proximal end of the labium to the posterior side of the head (the upper part of this muscle omitted); m^5, muscle from the hind wall of the membranous cone to the posterior side of the head outside the occipital foramen; m^6, pumping muscle; m^7, muscle from the posterior process of the pharynx to the solid chitin just outside the epistoma; m^8, muscle from the dilatation of the

salivary duct to the upper part of the hind wall of the pharynx; *n*, lower part of the salivary duct; *o*, upper part of the same.

FIG. 22.—Basal portion of external and distal portion of some of the internal mouth-parts of *Stomoxys calcitrans*, L., ♂, drawn by transmitted light; × 54: *a*, labrum; *b*, basal part of its left apodeme; *c*, basal part of the hypopharynx; *d*, base of hypopharynx and of the plate in the groove of the labrum; *e*, small part of the base of the plate in the labial groove; *f*, lower part of the pharynx itself; *g*, tube between the pharynx itself and labrum-hypopharynx; *h*, lower part of the salivary duct (the wall is thick); *i*, upper part of the same duct (the wall is thin, with linear circular thickenings); *k*, dilatation of the same duct; *m*, terminal part of its left muscle.

COPENHAGEN,
August 26, 1902.

CHAPTER VI.

BIBLIOGRAPHY.—PART I.

THE LITERATURE OF TSETSE-FLIES.

[In order to render the following Bibliography more useful to readers who happen to be specially interested in a particular region of Africa, the records of observations and occurrences are here shown classified under four main geographical headings :—

A. West Africa.

53, 56, 65, 65A, 80, 95, 99, 107, 122, 146, 148, 157, 162, 170, 171.

See also Chapter VII., Appendix H, p. 310.

B. East Africa (including Somaliland, and German and British East Africa).

1, 12, 25, 28, 43, 45, 47, 49, 54, 60, 62, 66, 71, 78, 79, 81, 94, 101, 102, 115, 117, 119, 120, 124, 126, 127, 133, 139, 144, 150, 151, 154, 155, 163, 164, 166, 167, 168, 169, 171, 174, xxvi.

See also Chapter VII., Appendix C, pp. 291–294, 296–297.

C. Central Africa (including the Valley of the Upper Nile, Uganda, and Nyasaland).

25A, 29, 37, 59, 61, 98, 111, 125, 138, 141, 145, 172.

See also Chapter VII., Appendix B, and Appendix C, p. 295.

D. South Africa (including the Zambesi Valley, and the country to the south).

5, 9, 11, 20, 21, 23, 26, 27, 28, 30, 36, 38, 40, 41, 42, 50, 52, 53, 55, 57, 64, 67, 69, 70, 72, 73, 74, 75, 76, 77, 85, 86, 93, 97, 98, 100, 104, 105, 105A, 106, 108, 110, 112, 114, 116, 118, 121, 128, 134, 135, 143, 149, 152, 153, 159, 160, 161, 165, 173.

See also Chapter VII., Appendix A, and Appendix C, p. 290.]

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1. 1813. James Bruce.

"TRAVELS TO DISCOVER THE SOURCE OF THE NILE": 3rd ed., 8vo., Vol. II., pp. 305–307 ; Vol. VII., pp. 300–303, 305 ; figure of the "*Tsaltsalya* or *Fly*," 4to ed. (1813), Vol. VII. (VIII.), No. 39.

"*Tsaltsalya* or *Fly*."—The fly, of which "Tsaltsalya" is the "Ethiopic" name, and "the true name of this particular fly in Geez," is stated to be confined to a district of "black fat earth," called Mazaga, on the Upper Atbara River, on the confines of the Sudan and Abyssinia. During the rains the cattle had to be taken down to the sandy plains of the Lower Atbara, to escape the fly (8vo ed. (1813), Vol. VII., pp. 300–303).

The figure of the Tsaltsalya is poor, and represents an insect with hairy body and legs, but it is apparently meant either for a *Pangonia* (Family Tabanidæ) or a Tsetse.

"The insect is called Zimb, in modern or vulgar Arabic; it has not been described by any naturalist. It is in size very little larger than a bee, of a thicker proportion, and the wings, which are broader than those of a bee, are placed separate like those of a fly; they are of pure gauze, without colour or spot upon them; the head is large, the upper jaw or lip is sharp, and has at the end of it a strong pointed hair of about a quarter of an inch long; the lower jaw has two of these pointed hairs, and this pencil of hairs, when joined together, makes a resistance to the finger nearly equal to that of a strong hog's bristle. Its legs are serrated in the inside; and the whole covered with brown hair, or down. As soon as this plague appears, and its buzzing is heard, all the cattle forsake their food, and run wildly about the plain, till they die, worn out with fatigue, fright, and hunger. No remedy remains, but to leave the black earth, and to hasten down to the sands of Atbara; and there they remain while the rains last, this cruel enemy never daring to pursue them farther" (8vo ed., Vol. VII., p. 305).

[The description of the size of the insect—"very little larger than a bee, of a thicker proportion," with wings "broader than those of a bee," and placed separate like those of a fly"—is suggestive of *Pangonia* rather than *Glossina*.]

"All the inhabitants of the sea-coast of Melinda, down to Cape Gardefan [*sic*], Saba, and the south coast of the Red Sea, are obliged to put themselves in motion, and change their habitation to the next sand in the beginning of the rainy season, to prevent all their stock

of cattle from being destroyed. This is not a partial emigration; the inhabitants of all the countries from the mountains of Abyssinia northward, to the confluence of the Nile and Astaboras [Atbara], are once a year obliged to change their abode, and seek protection in the sands of Beja; nor is there any alternative, or means of avoiding it, though a hostile band was in their way, capable of spoiling them of half their substance. . . ." (8vo ed., Vol. II., pp. 306–307).

[Bruce considers that this is the fly referred to in the following passage in Isaiah, vii. 18 and 19:—"And it shall come to pass, in that day, that the Lord shall hiss for the fly that is in the uttermost part of the rivers of Egypt, and for the bee that is in the land of Assyria. And they shall come, and shall rest all of them in the desolate vallies, and in the holes of the rocks, and upon all thorns, and upon all bushes."

Westwood believes Bruce's "Zimb" to be the Tsetse, "or at least that that insect is a larger species of *Glossina*, to whose real habits Bruce has added those of a species of *Œstrus*" (P. Z. S., 1850, p. 262). *If Westwood is right it follows that the range of the Tsetse extends to the Sudan, on the confines of Abyssinia.*]

2. 1830. **C. R. W. Wiedemann.**

"Aussereuropäische zweiflügelige Insekten," Zweiter Theil: pp. 253–254, Taf. IX., Figs. 10^a, 10^b, 10^c.

Original description of the genus *Glossina*, and of *Gl. longipalpis*.

3. 1830. **J. B. Robineau-Desvoidy.**

"Essai sur les Myodaires" (*Mémoires présentés par divers Savans à l'Académie Royale des Sciences de l'Institut de France.* Tome Deuxième), pp. 389–390.

Original description of the genus *Nemorhina*, and of *N.* (*Glossina*) *palpalis*.

4. 1835. **J. Macquart.**

"Histoire Naturelle des Insectes. Diptères": Tome Deuxième, pp. 244–245, Pl. 16, Fig. 8.

Description of the genus *Glossina*, and of *Gl. longipalpis* (apparently the true *Gl. longipalpis*, Wied.). The figure is a caricature.

5. 1839. **Captain (afterwards Sir) William Cornwallis Harris.**

"The Wild Sports of Southern Africa" (London: John Murray), p. 231.

A passage referring to the occurrence of Tsetse in the Mural Berge—a range of hills in the Waterberg District of the present Transvaal, on the south bank of the Limpopo, close to the intersection of the 27th parallel E. longitude and the Tropic of Capricorn—in November, 1836. Although not mentioned by name, it is very evident that the Tsetse is the fly alluded to. The author writes:—"Here the country again assumes a more level character, but is broken to the eastward by detached hills and low ridges, imperceptibly increasing in importance, until they grow into a great range of mountains, known to the natives as the Mural. . . . During the rainy season especially, they are infested by a large species of gad-fly, nearly the size of a honey-bee, the bite of which, like that of a similar pest in Abyssinia, proves fatal to cattle. A desire to escape the officious visits of these destructive insects, whose persecutions relieved us of two of our oxen, soon obliged us to abandon the willow-fringed river, which threads the mountains for a considerable distance. . . ."

In the map at the end of the volume, entitled "Africa North-East of the Cape Colony, exhibiting the relative positions of the Emigrant Farmers and the Native Tribes, May, 1837," the position of the Mural Berge is not quite correctly indicated. They are there called the "Murat [*sic*] Mount^{ns}," and are marked as "abounding in flies destructive to cattle."

6. 1843. **J. Macquart.**

"Diptères Exotiques Nouveaux ou Peu Connus": Tome Deuxième. 3^{e} Partie, pp. 112–114, Tab. 14, Fig. 1, 1^{a}.

Description of the genus *Glossina*, and notes as to its affinities and probable habits: description of *Gl. longipalpis* ♀ (? = *Gl. morsitans*, Westw.). The figure of the insect is very poor.

7. 1849. **F. Walker.**

"List of the Specimens of Dipterous Insects in the Collection of the British Museum." Part III. p. 682.

Original description of *Stomoxys fuscus* (*Glossina fusca*), and description of "*Stomoxys longipalpis? Glossina longipalpis*" (= *Glossina palpalis*, Rob.-Desv.).

8. 1850. **J. Macquart.**

"Diptères Exotiques Nouveaux ou Peu Connus." 4e Supplément, p. 239, Tab. 22, fig. 4.

Description of *Glossina longipalpis* ♂ (?) (*Gl. morsitans*, Westw.). The figure is an unrecognisable profile of the abdomen.

9. 1850. **R. Gordon Cumming.**

"Five Years of a Hunter's Life in the Far Interior of South Africa" (London: John Murray), Vol. II., pp. 210, 219–220, 227, 270.

"They [natives] also told me that I should lose all my cattle by the fly called 'Tsetse'" (p. 210). "When under the mountains [on the south bank of the Limpopo river, in the Zoutpansberg district of what is now the Transvaal], I met with the famous fly called 'Tsetse,' whose bite is certain death to oxen and horses. This 'hunter's scourge' is similar to a fly in Scotland called 'kleg,' but a little smaller; they are very quick and active, and storm a horse like a swarm of bees, alighting on him in hundreds and drinking his blood. The animal thus bitten pines away and dies at periods varying from a week to three months, according to the extent to which he has been bitten" (pp. 219–220). "The next day one of my steeds died of 'tsetse.' He had been bitten under the mountain range lying to the south of this fountain. The head and body of the poor animal swelled up in a most distressing manner before he died. His eyes were so swollen that he could not see, and in darkness he neighed for his comrades who stood feeding beside him" (p. 227). Death of a pony from "Tsetse" (p. 270).

10. 1850. **J. O. Westwood.**

"Observations on the Destructive Species of Dipterous Insects known in Africa under the Names of the Tsetse, Zimb, and Tsaltsalya, and on their supposed Connexion with the Fourth Plague of Egypt" (*Proceedings of the Zoological Society of London.* Part XVIII., pp. 258–270, Pl. XIX., figs. 1, 1a–1f, 2, 3).

Includes the original description and figures of *Glossina morsitans*, *tachinoides* (= *palpalis*, Rob.-Desv.—*var.*), and *tabaniformis* (= *fusca*, Walk.).

11. 1852. **W. Cotton Oswell.**

"Sur une Mouche venimeuse de l'Afrique méridionale" (*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Tome Trente-Cinquième, pp. 560–561).

A note, translated in "Ann. Mag. Nat. Hist.," Ser. 2, Vol. X., p. 463.

12. 1852. — **Arnaud.**

Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences, Tome Trente-Cinquième, p. 603.

A note to the effect that the fly brought home and presented to the Société de Géographie by Mr. Oswell seemed to the author to be the same as that met with in the Isle of Sennâr (translated in "Ann. Mag. Nat. Hist.," Ser. 2, X., p. 464).

The following is a translation of M. Arnaud's note: "From the examination that I was able to make of this fly in the office of the Société de Géographie, it seemed to me to be identical with the one met with in the Isle of Sennâr, between 15° and 11° north latitude, where its repeated punctures likewise kill animals, obliging shepherds, especially those who keep cattle, to abandon the country during the season at which it is most troublesome, that is to say, in the months from January to May, in order to take refuge on the banks of the Nile, where the fly is only very rarely found.

"I have myself been bitten by one of these flies, and the sore that resulted lasted more than four months, with insupportable itchings, which sometimes recur even to-day."

[Whether the fly here referred to is a species of Tsetse or not, it seems highly probable that it is identical with the "Zimb" or "Tsaltsalya" of Bruce. The statement that the Sennâr fly avoids the banks of the Nile certainly suggests the idea that it is not a Tsetse, though the same objection might be urged against its being what is known in the Sudan as a "Seroot" fly, *i.e.*, one of the Tabanidæ, either a species of *Tabanus* near *T. dorsivitta*, Walk., or else a *Pangonia*. In the paper by E. Marno, published in

Petermann's "Mittheilungen" for 1873 (see 47), the fly is called *Surrēta*, under which name, however, it is stated that a large number of species is included.]

13. 1852. De la Roquette.

"Mouche venimeuse de l'Afrique méridionale" (*L'Institut*, Tome XX, p. 342).

Reprints of the notes by Oswell and Arnaud in the *Comptes Rendus*.

14. 1852. J. O. Westwood.

"Observations on the Destructive Species of Dipterous Insects known in Africa under the Names of the Tsetse, Zimb, and Tsaltsalya, and on their supposed Connexion with the Fourth Plague of Egypt" (*Annals and Magazine of Natural History*, Vol. X., Second Series, pp. 138–150).

Reprint of the paper in the P. Z. S. of 1850, without the figures.

15. 1852. W. C. Oswell and — Arnaud.

"On a Venomous Fly of Southern Africa" (*Annals and Magazine of Natural History*, Vol. X., Second Series, pp. 463–464).

Translations of notes by the authors in *Comptes Rendus*, Tome 35 (1852), pp. 560 and 603. Mr. Oswell's note was afterwards printed in somewhat greater detail in the Proceedings of the Entomological Society of London, 1852, p. 96 (1853) [see 18]. M. Arnaud, after examining one of Mr. Oswell's specimens, considered it identical with a cattle-destroying fly "found in the Isle of Sennâr, between 15° and 11° N. latitude" [see 12].

16. 1852. H. Schaum.

Archiv für Naturgeschichte, 18. Jahrgang, II. Band, pp. 236–237.

Résumé of Westwood's paper in the P. Z. S. of 1850.

17. 1853. H. Schaum.

Archiv für Naturgeschichte, 19. Jahrgang, II. Band, pp. 268–269.

Summary of the notes by W. C. Oswell (*Comptes Rendus*, T. 35 (1852), p. 560), and Mons. Arnaud (*op. cit.*, p. 603), translated in Ann. Mag. Nat. Hist., Ser. 2, X., pp. 463–464.

18. 1853. W. Cotton Oswell.

Proceedings of the Entomological Society of London, 1853, pp. 96–97.

Observations on the Tsetse-fly of South Africa, communicated by Mr. W. B. Spence.

19. 1853. J. O. Westwood.

Proceedings of the Entomological Society of London, 1852, p. 85.

Bibliographical notes.

20. 1856. C. J. Andersson.

"Lake Ngami, or, Explorations and Discoveries, During Four Years' Wanderings in the Wilds of South-Western Africa" (London: Hurst and Blackett). Chapter XXXVII., pp. 488–491.

"During my hunting excursions along the Teoge, I encountered, for the first time, that most extraordinary of insects, the Tsetse (*Glossina morsitans*, Westw.). Among the several scourges to which the traveller is subjected in the South African wilderness, one of the greatest is this insect; not, it is true, as to the wayfarer's own person, for he himself escapes almost unscathed, but as regards the horses and cattle.

"The Tsetse is found chiefly in the bush, or amongst the reeds, but rarely in the open country. It is confined to particular spots, and is never known to shift its haunts. Thus, cattle may be seen grazing securely on one side of a river, whilst the opposite bank swarms with the insect. Should the natives, who are well acquainted with localities frequented by the fly, have occasion to change their cattle-posts, and are obliged to pass through tracts of country where it exists, they choose, I am told, a moonlight winter's night, as, during the hours of rest in the cold season, it does not bite" (pp. 488–489).

"Very lately, indeed, a party of Griquas, about twenty in number, who were elephant-hunting to the north-west of the Ngami, and who were provided with three waggons and a large number of trek or draught oxen, lost, prior to their return to the Lake, all their cattle by the bite of the Tsetse. Some horses brought with them to further their sport shared a similar fate.

"The very same year that this disaster happened to

the Griquas, a party of Englishmen, amongst whom was my friend, Mr. Frederick Green, attempted to reach Libèbé; but they had only proceeded seven or eight days' journey to the north of the Ngami, when both horses and cattle were bitten by the fly in question, and the party were in consequence compelled to make a hasty retreat. One of the number, I am told, was thus deprived of as many as thirty-six horses, excellent hunters, and all sustained heavy losses in cattle" (pp. 489–490).

"When allowed to settle on the hand of a man, all it is observed to do is to insert its proboscis a little farther than seems necessary to draw blood. It then partially withdraws the dart, which assumes a crimson hue. The mandibles now appear to be agitated; the shrunken body swells, and, in a few seconds, the insect becomes quite full, and quietly abandons its prey" (p. 490, note).

"A dog, reared on the meat of *game*, may be hunted in Tsetse districts in safety" (p. 491, note 2).

21. 1857. David Livingstone.

"MISSIONARY TRAVELS AND RESEARCHES IN SOUTH AFRICA" (London: John Murray), pp. 79, 80–83, 487–488, 571.

"The cattle, in rushing along to the water in the Mababe, probably crossed a small patch of trees containing Tsétsé, an insect which was shortly to become a perfect pest to us" (p. 79).

"A few remarks on the Tsetse, or *Glossina morsitans*, may here be appropriate. It is not much larger than the common house-fly, and is nearly of the same brown colour as the common honey-bee. The after part of the body has three or four yellow bars across it; the wings project beyond this part considerably, and it is remarkably alert, avoiding most dextrously all attempts to capture it with the hand at common temperatures; in the cool of the mornings and evenings it is less agile. Its peculiar buzz, when once heard, can never be forgotten by the traveller whose means of locomotion are domestic animals; for it is well known that the bite of this poisonous insect is certain death to the ox, horse and dog. In this journey, though we were not aware of any great number having at any time lighted on our cattle, we lost forty-three oxen by its

bite. We watched the animals carefully, and believe that not a score of flies were ever upon them.

"A most remarkable feature in the bite of the Tsetse is its perfect harmlessness in man and wild animals, and even calves, so long as they continue to suck the cows. We never experienced the slightest injury from them ourselves, personally, although we lived two months in their habitat, which was in this case as sharply defined as in many others, for the south bank of the Chobe was infested by them, and the northern bank, where our cattle were placed, only fifty yards distant, contained not a single specimen. This was the more remarkable, as we often saw natives carrying over raw meat to the opposite bank with many Tsetse settled upon it" (pp. 80–81).

Notes on the bite and its effects on cattle (pp. 81–82).

"These symptoms seem to indicate what is probably the case, a poison in the blood, the germ of which enters when the proboscis is inserted to draw blood. The poison-germ, contained in a bulb at the root of the proboscis, seems capable, although very minute in quantity, of reproducing itself, for the blood after death by Tsetse is very small in quantity, and scarcely stains the hands in dissection" (p. 82). Animals that suffer from the bite, or possess immunity (p. 82). "The mule, ass, and goat enjoy the same immunity from the Tsetse as man and the game."

"The curious feature in the case, that dogs perish though fed on milk, whereas the calves escape so long as they continue sucking, made us imagine that the mischief might be produced by some plant in the locality, and not by the Tsetse; but Major Vardon, of the Madras Army, settled that point by riding a horse up to a small hill infested by the insect without allowing him time to graze, and though he only remained long enough to take a view of the country and catch some specimens of Tsetse on the animal, in ten days afterwards the horse was dead.'

"The well-known disgust which the Tsetse shows to animal excreta, as exhibited when a village is placed in its habitat, has been observed and turned to account by some of the doctors. They mix the droppings of animals, human milk, and some medicines together, and smear the

animals that are about to pass through a Tsetse district: but this, through it proves a preventive at the time, is not permanent. There is no cure yet known for the disease. A careless herdsman, allowing a large number of cattle to wander into a Tsetse district, loses all except the calves; and Sebituane once lost nearly the entire cattle of his tribe—very many thousands—by unwittingly coming under its influence. Inoculation does not insure immunity, as animals which have been slightly bitten in one year may perish by a greater number of bites in the next; but it is probable that with the increase of guns the game will perish, as has happened in the south, and the Tsetse, deprived of food, may become extinct simultaneously with the larger animals" (pp. 82–83).

"Before reaching the Makondo rivulet, latitude 13° 23′ 12″ S., we came upon the Tsetse in such numbers, that many bites were inflicted on my poor ox, in spite of a man with a branch warding them off. The bite of this insect does not affect the donkey as it does cattle. The next morning, the spots on which my ox had been bitten were marked by patches of hair, about half-an-inch broad, being wetted by exudation (pp. 487–488).

Tsetse met with on the banks of the Chiponga, which joins the Kafue a few miles above its confluence with the Zambesi.

Figures of *Glossina morsitans* (enlarged) and mouth parts (copied from Westwood's figures in P. Z. S., 1850), also small rough woodcut of Tsetse, about natural size (from figures supplied by Mr. J. E. Gray) (p. 571).

The enlarged figure of the fly is also reproduced on the title-page of the volume.

22. 1857. Bracy Clark.

"The Tzetze of Africa identified with Œstrus Bovis" (*The Zoologist*, Vol. XV., pp. 5720–5721).

A mistaken attempt to show that the Tsetse is identical with the cattle Warble-fly (*Œstrus* (*Hypoderma*) *bovis*).

23. 1858. L. de Castelnau.

"Sur la Tsétsé de l'Afrique australe" (*Comptes Rendus hebdomadaires des Séances de l'Académie des Sciences*, Tome Quarante-Sixième, pp. 984–986).

The Tsetse "is generally found on bushes and reeds

bordering marshes, while the plains and other open places seem less favourable to it" (p. 984).

"It occurs in great numbers between—

22° and 26° E. long. (Greenwich) and 18° and 21° S. lat.
25° and 27° ,, ,, ,, ,, 19° and 20° ,, ,,
27° and 29° ,, ,, ,, ,, 22° and 25° ,, ,,
26° and 28° ,, ,, ,, ,, 24° and 25° ,, ,, (p. 984).

"A little time ago, some Griquas having with them eight waggons, attempted to cross the country in which this insect lives to the north-west of the Transvaal Republic. They lost all their animals, and were obliged to abandon their waggons and return on foot" (p. 984).

"This fly seems to live only in localities in which game abounds. . . . It appears neither to increase nor to diminish in number, according to the statements of traders, though, as in all parts of South Africa, the natives are in the habit of setting fire to the pasture every year. . . . The Tsetse most usually attacks the region between the thighs and the belly of animals. . . ." (p. 985).

"The Tsetse has no uncertain flight, like most of the other Diptera; quick as an arrow, it darts from the top of a bush to the point that it wishes to attack; it seems also to possess very keen sight. Mr. Chapman, one of the travellers who has penetrated farthest into the interior of South Africa, narrates that while out shooting, having an almost imperceptible hole in his clothing, made by a thorn, he often saw the Tsetse, which appeared to know that it could not penetrate the cloth that he was wearing, make a dart and succeed, without ever missing its aim, in biting him in the small space that was not protected.

"The Bushmen assert that this fly is viviparous, and Mr. Edwards, the companion of Mr. Chapman, and a highly intelligent man, having one day expressed to them his disbelief as to this, they brought him a pregnant female, and having in his presence opened it along the middle line of the abdomen, he states that he saw three little flies ready to take flight emerge from it" [!!] (p. 986).

24. 1858. J. O. Westwood.

EXHIBITION BY WESTWOOD AT A MEETING OF THE ENTOMOLOGICAL SOCIETY OF LONDON, HELD OCTOBER 5TH, 1857, OF A SPECIMEN OF THE TSETSE BROUGHT HOME BY

Major Vardon (*again erroneously said to be from Lake Tchad*). (*Transactions of the Entomological Society of London, New Series*, Vol. IV., pp. 89–90). Westwood refutes Bracy's Clark's contention (*vide* 22) that Tsetse is merely another name for "*Œstrus bovis*."

25. 1860. Captain R. F. Burton.

"The Lake Regions of Central Africa" (London: Longman, Green, Longman, and Roberts), Vol. I., pp. 187, 276, 289; Vol. II., pp. 18–19.

"In this foul jungle [inland from Bagamoyo, bordering the path leading from Mbumi along the right bank of the Mukondokwa River to its ford], our men also suffered severely from the Tzetze. This fly, the torment of Cape travellers, was limited, by Dr. Livingstone, to the regions south of the Zambezi River. A specimen, brought home by me and submitted to Mr. Adam White, of the British Museum, was pronounced by him to be a true *Glossina morsitans*, and Mr. Petherick has fixed its limits about eight degrees north of the equator. On the line followed by the Expedition, the Tzetze was found extending from Usagara westward as far as the Central Lakes; its usual habitat is the jungle-strip which encloses each patch of cultivated ground, and in the latter it is rarely seen. It has more persistency of purpose even than the Egyptian fly, and when beaten off it will return half a dozen times to the charge; it cannot be killed except by a smart blow, and its long, sharp proboscis draws blood even through a canvas hammock. It is not feared by the naked traveller; the sting is as painful as that of an English horse-fly, and leaves a lasting trace, but this hard-skinned people expect no evil consequences from it. In the vicinity of Kilwa it was heard of under the name of 'kipanga,' the 'little sword'" (Vol. I., p. 187).

Tsetse abundant at K'hok'ho, in Usenga (now German East Africa) (Vol. I., p. 276).

Tsetse in a thin forest of thorns and gums, bare of bush and underwood, near Jiwe la Mkoa, in Mgunda Mk'hali.—"On the next day the road led through a thin forest of thorns and gums, which, bare of bush and underwood, afforded a broad path and pleasant, easy travelling. Sign of elephant and rhinoceros, giraffe and antelope, crossed

the path, and as usual in such places, the asses were tormented by the Tzetze" (Vol. I., p. 289).

Tsetse-fly (apparently) *in Unyamwezi* (to the east of Lake Tanganyika).—"The Arabs describe a fly which infests the forest-patches of Unyamwezi; it is about the size of a small wasp, and is so fatal that cattle attacked by it are at once killed and eaten before they become carrion from its venomous effects" (Vol. II., pp. 18–19).

For localities, see Map at the end of Vol. II.

25a. 1862. Dr. (now Sir) John Kirk.

REPORT ON THE NATURAL PRODUCTS AND CAPABILITIES OF THE SHIRÉ AND LOWER ZAMBESI VALLEYS. By John Kirk, Botanist to the Livingstone Expedition. Dated Senna, Dec. 28th, 1860 (*Proceedings of the Royal Geographical Society of London*, Vol. VI., p. 29).

"The Tsetse-fly is unknown among the hills, and very rare in the Upper Shiré Valley on the eastern side. In the lower valley, however, it is the natural accompaniment of the large herds of elephants which inhabit the grass plains and marshes."

26. 1864. Thomas Baines.*

"EXPLORATIONS IN SOUTH-WEST AFRICA" (London: Longman, Green, Longman, Roberts and Green), pp. 255, 351, 469, 470–471, 511.

Bushman remedy for Tsetse-bite.—"On a former occasion a Bushman gave Chapman a remedy for the bite of the Tsetse; it seemed to be a parasitic plant growing either in the hollow of a tree or between the wood and the bark. Chapman thought it acted by restoring to the blood the iron of which perhaps the bite of the fly deprived it, but he sent it home with other specimens by a friend, and has not yet heard any report on it" (p. 255).

Tsetse on the Teoge River, a tributary of Lake Ngami from the north (1862).—"This is not unlikely to be the Teoge River, and if so, it would not do to take the cattle near it on account of the fly" (p. 351).

Tsetse on the Zimboya River, a tributary of the Matietsie River, south-west of Victoria Falls (July, 1862).—". . . we were riding on the track by which

* Baines accompanied Chapman in his travels.

I had returned, when Chapman came galloping back for life (not his own but his horse's). A fly had settled on the rump of his steed, and though he had driven it off, he could be by no means sure that others had not sucked blood, and left the subtle venom with which they dilute it. We altered our course, and held more north along the rivulet in the open places, galloping the oxen whenever we were forced to enter the bush. A herd of waterboks appeared; Chapman wounded one and gave chase, but again the fly attacked him and forced him to a precipitate retreat" (pp. 469–470).

[*Zimboya R.*] "I saw a dozen of the dreaded little pests hovering with that rapid motion of the wing that keeps the insect stationary over the devoted cattle [trek-oxen]; but near an hour passed before we were again ready to move, and a few minutes of that time has most likely served to inject the poison which dooms twelve working oxen, two horses, and the cows, to a painful and lingering death. No one can be assured of this, till in three weeks or so the staring eye and roughened coat begin to tell the tale of gradual waste. I heartily wish (hope, I can hardly say) we may be mistaken, but our guide, who had seen no fly, when asked whether he was certain on the point, replied with an air of astonishment, 'Is then the Tsetse a thing that a man forgets when he has once seen it?'" (pp. 470–71).

Tsetse at the Victoria Falls.—"Another hindrance is the annoyance caused to the painter [of the Falls] by the incessant persecutions of the Tsetse. At the moment, perhaps, when one requires the utmost steadiness and delicacy of hand, a dozen of these little pests take advantage of his stillness, and simultaneously plunge their preparatory lancets into the neck, wrists, and the tenderest parts of the body; one or more cunning fellows actually selecting the places where the lines of fortune radiate or cross, with a skill in palmistry that would do honour to an experienced gipsy" (p. 511).

27. 1865. David and Charles Livingstone.

"Narrative of an Expedition to the Zambesi and its Tributaries" (London: John Murray), pp. 206–207, 232–233, 424.

Tsetse near the Valley of the Zambesi, to the west of Zumbo.—"We left the river here, and proceeded up the valley which leads to the Mburuma or Mohango pass. . . . Tsetse-flies are more numerous and troublesome than we have ever before found them. They accompany us on the march, often buzzing round our heads like a swarm of bees. They are very cunning, and when intending to bite, alight so gently that their presence is not perceived till they thrust in their lance-like proboscis. The bite is acute, but the pain is over in a moment; it is followed by a little of the disagreeable itching of the mosquito's bite. This fly invariably kills all domestic animals except goats and donkeys; man and the wild animals escape. We ourselves were severely bitten on this pass, and so were our donkeys, but neither suffered from any after effects" (pp. 206–207).

Batoka remedy for Tsetse-bite.—"Another [Batoka] Chief, who died a number of years ago, believed that he had discovered a remedy for Tsetse-bitten cattle; his son Moyara showed us a plant, which was new to our botanist, and likewise told us how the medicine was prepared; the bark of the root, and, what might please our homœopathic friends, a dozen of the Tsetse are dried and ground together into a fine powder. This mixture is administered internally, and the cattle are fumigated by burning under them the rest of the plant collected. The treatment must be continued for weeks, whenever the symptoms of poison appear. This medicine, he frankly admitted, would not cure all the bitten cattle. 'For,' said he, 'cattle, and men too, die in spite of medicine; but should a herd by accident stray into a Tsetse district and be bitten, by this medicine of my father's, Kampakampa, some of them could be saved, while, without it, all would inevitably die.' He stipulated that we were not to show the medicine to other people, and if ever we needed it in this region we must employ him; but if we were far off we might make it ourselves; and when we saw it cure the cattle think of him, and send him a present" (pp. 232–233).

Native ideas of mode of reproduction of the Tsetse.—"Our distinguished countryman, Professor Owen, recommended our attention to be directed to the genesis of the Tsetse, in order to discover a means for the extirpation

of this pest. We frequently inquired of the different tribes if they could help us in our inquiries; and one of the Makololo remembered that this very question was once under public discussion at Linyanti; and, as usual, a bet was laid that no one could tell. After a number of days had elapsed, an old man claimed the prize, asserting that the Tsetse laid its eggs, which were of a red colour, on the leaves of the mopane tree. These were probably only the eggs of an insect, described in the 'Missionary Travels,' as depositing over its eggs a sweet gum, which is collected and eaten. Some denied that he had seen them; others affirmed that the red eggs were laid on the twigs of trees, and not on the leaves; and others insisted that the eggs were placed in the droppings of buffaloes, and these last were probably in the right. The destruction of all game by the advance of civilization is the only chance of getting rid of the Tsetse" (p. 424).

28. 1865. Dr. (now Sir) John Kirk.

"On the 'Tsetse' Fly of Tropical Africa" (*Glossina morsitans*, Westwood) (*The Journal of the Linnean Society*, Vol. VIII., pp. 149–156).

"During the Zambezi Expedition, the 'Tsetse' Fly has been met with by us on many occasions and at distant parts. It was first seen on the Zambezi at Lupata, a hilly and well-wooded district 150 miles from the coast. To the north-east, between the Zambezi and Shire, it is very abundant. In some parts of the Batoka country, near the Victoria Falls, it was again found; also at the junction of the Chobe; and in immense numbers on the south bank, not far from the confluence of the Kafue.

"On the Rovuma river in 10° S. Lat. it is met with eight miles from the coast, and extends along its banks for 115 miles, the furthest point explored; here we found it named 'Chipinga'; 'Kipanga' being that given to it at Kilwa, according to Captain Burton. Wherever met with over this wide area of Tropical Africa south of the equator, the habits of this fly as recorded are the same.

"It frequents open forest and well-wooded country, being absent from extensive grass plains. In the morning while the dew hangs on the grass, and before the heat of the rising sun has warmed the air, the 'Tsetse' is dull

and sluggish, resting on the under side of some leaf or blade of grass; when forced to take wing they may then be easily caught.

"Even at nine o'clock they are not very active, and fly about with a peculiar buzzing sound; with the heat of the day they become a real annoyance to the traveller, constantly biting him on the hands, face, or neck, dextrously evading a blow, and again alighting on the very spot from which they have been driven. If permitted, they will gorge themselves with blood and become unable to fly to a distance. On man, the effects are not more than follow an ordinary mosquito bite, redness, swelling, and local irritation remaining for about an hour, varying in amount according to the state of the individual. In itself the bite is not so severe as that of the larger Tabanidae.

"By night I have never been bitten by 'Tsetse,' nor do they fly about after sunset. They are most numerous and troublesome in the hot, sultry weather before rains.

"When once attention has been directed to the fly, it cannot again be overlooked, although, from its common and insignificant appearance, others might easily be confounded with it by those who have not before experienced it. There is, therefore, more danger of its geographical range being exaggerated than under-estimated. Wherever I have found this fly, it has been accompanied by the buffalo or elephant; the native dog and goat are the only domestic mammals I have found in a country infested by it."

* * * * *

"Although always found in company with large game, the fly does not follow it everywhere; other circumstances, still unknown, check its universal distribution.

"Between Sesheke and Linyanti there is plenty of game, yet the fly is limited to certain narrow spots, and in like manner between Sesheke and the Victoria Falls. So are these falls shut out from the south by only a narrow belt of 'fly' land, which may be crossed at night.

"As much of what we know on these points rests on native information, I would remark that where the person obtaining it enjoys the confidence of the people and can speak with them in a common language, without depending

on interpreters, native testimony on matters of fact is quite as good as European.

"The Makalolo are a people from infancy accustomed to tend cattle, possessing a thorough knowledge of the most fattening pastures to be sought, and noxious herbs to be avoided. Their only wealth consists in cattle, which they number by thousands. All affirm that on entering certain localities by day the oxen die shortly afterwards; this they have proved, not in the small numbers of twenty or forty noticed by Europeans, but in herds consisting of hundreds; whether in great or small numbers they have found the result alike. They have further learned that these deadly places may be crossed with safety by night if sufficiently narrow to allow of the cattle being driven through before sunrise. This has been tested by Europeans and found also correct; further, that goats remain unaffected, and sheep suffer in a less degree than oxen."

* * * * *

"The fly avoids human excrement, so the natives told us, and we have found it true, and they say that cattle have been passed by day through fly country when smeared with a composition containing this. Native doctors have an herb to which they attribute a similar effect, but even they never assert that it will save all; only a small per cent. of the cattle exposed is the most they claim" (pp. 152–154).

Lung-sickness, African distemper, etc., "differ manifestly from the 'Tsetse' disease in being contagious and spreading from one place to another and from one animal to another, whereas only those bitten by the fly die; and no danger has been apprehended or experienced by such cattle mixing with others" (p. 154).

"The first symptoms [of Tsetse-fly disease] appear commonly within four days, but this varies with the number of flies and the season of the year. Natives report that cattle bitten die in greatest numbers before the rains, or when they set in, and that some animals will linger on until then; that having passed a fly country you do not know the full amount of loss until the rainy season has begun" (p. 155).

* * * * *

"In most Tsetse countries the traveller is not usually beset with more than two or three at a time; in the course of the heat of the day these might produce a number of bites, besides falling in with fresh flies as one advanced. But they are sometimes found in much greater numbers. On the south side of the Zambezi, near the confluence of the Kafue, while walking along the river-bank in search of game, under flat-topped acacias, I heard a buzzing sound, and saw a cloud of insects coming towards me. Supposing them a swarm of bees, I ran off, while they followed. On looking back I found it was only 'Tsetse'; so, arming myself with a leafy branch, I kept them off and continued my journey; they accompanied me for some distance however. I have never again seen them congregate in this manner; and, curiously enough, on this occasion, and on this only, did I obtain two of what may be the male insect; these bear the proportion to the females of 1 : 30,* judging by the numbers then caught" (p. 155).

General description of the structure and mode of action of the proboscis (pp. 155–156).

The fatal effect of the bite of the Tsetse in the case of domestic animals ascribed to "irritant matter" injected by the fly, in order to "facilitate the sucking of blood."

"The irritation which follows the bite in man shows that some irritant matter is at the same time injected (although no organ for its secretion has yet been detected), the object of which is no doubt to cause a local congestion, and thus facilitate the sucking of blood. The accidental effects of this, which in animals among whom the 'Tsetse' naturally lives produces no after result, in the domestic animals before-named proves fatal" (p. 156).

29. 1866. Sir Samuel W. Baker.

"The Albert N'yanza, Great Basin of the Nile, and Explorations of the Nile Sources" (London: Macmillan & Co.): Vol. I., p. 376.

Tsetse-fly in Obbo (S.E. of Gondokoro, just north of 4° N. lat., and between 32° and 33° E. long.).—"The wet herbage disagreed with my baggage animals. Innumerable flies appeared, including the Tsetse, and in a few weeks the donkeys had no hair left, either on their

* [*Cf.* p. 86.]

ears or legs; they drooped and died one by one. It was in vain that I erected sheds and lighted fires; nothing would protect them from the flies."

30. 1868. James Chapman.

"TRAVELS IN THE INTERIOR OF SOUTH AFRICA" (London: Bell and Daldy; Edward Stanford): Vol. I., pp. 174–177, 180; Vol. II., pp. 214, 225, 249–250.

Makololo remedy for calves suffering from Tsetse bite.—"Their [the Makololo's] cattle are carefully kept in the plains, or in parts known to be perfectly free of fly. The only remedy they use, they say, is to administer the fly in milk to a fly-bitten calf, but they do not seem to be very sanguine about the cure" (Vol. I., p. 174).

"Now a word with regard to that insignificant-looking insect, the Tsetse, or poison-fly. This great barrier to African travelling was first met by the Boers and other travellers on the Limpopo; and though most people on their first encounters felt doubts regarding its repute of the sting being fatal to horses and cattle, too painful experience of its ravages has left no doubt on the subject" (Vol. I., pp. 174–175).

"The Tsetse is, in extreme length, half an inch, or very little more, and has very much the appearance of a young bee just escaped from its cell, or a bee half-drowned in honey, the wings being always closed when stationary. . . . It is extremely quick of sight and keen of scent; its flight is rapid and straight.

"The bite of the Tsetse is something like that of the mosquito, but the pain is not so lasting. It assails different animals in their most defenceless parts: a man behind the back between the shoulders, and an ox on the back or under the belly; a horse in the same places, and inside the nostrils; and a dog on the forehead, etc. With the proboscis they penetrate a pilot cloth coat and whole suit of under-clothes. The bite of this insect is fatal to cattle, horses, sheep, and dogs; but there is a peculiar breed of the latter known as *Makoba* dogs, which are exempt from the effects of its poison, the breed having from time immemorial been reared in the "fly" country, and escaped a *cow milk diet*, as the natives say. It has no ill-effects whatever on game or upon men, except that

the being bitten by numbers is likely to induce headache, as with the irritation of mosquitoes. The symptoms, as I have observed them, are, first, in the ox, a swelling under the throat, which, if lanced, emits a yellowish fluid. The hair stands on end, or is reversed. The animals become debilitated; and, though the herbage be ever so luxuriant, refuse to eat their fill, and become thin. The eyes water, and at length, when the end is approaching, a continual rattling in the throat may be heard at a few paces' distance. It sometimes happens that a fly-bitten ox will live, but very rarely, and only when it has no work to perform. Work and rain are great precipitators of their end. In horses the symptoms are swelling about the eyes, nostrils, testes, the hair is reversed, and, though they have the best of food, they become thin, sleepy, and, pining gradually, at length die.

"Both cattle and horses live from fourteen days to six months after having been bitten by Tsetse, but they generally die after the first rain has fallen. A dog dies in ten or twelve days, or two or three weeks at latest. It is perceptible in the eyes, which are swollen and protruding. After death the heart of an ox is generally incased in a yellowish glutinous substance, which might be mistaken for fat. The flesh is full of little bladders of fluid, and the blood also is half fluid, which becomes congealed on cooling. The vitals are of a livid colour.

"The Tsetse-fly is generally found within a few miles of water, in rich sandy ridges near marshy spots, and generally in mopani or mimosa forests. I have known them to shift their positions, or encroach on new ground, or leave parts where fire-arms have driven the game out of a district. They are mostly only found within a certain range from water. To the buffalo in particular the insect is more attached, and often moves about with them in the rainy season" (Vol. I., pp. 175–177).

Author's oxen and horses discovered to have been bitten by the fly, *in the Makololo Country, on the Chobé River*, W. of the Victoria Falls: two or three cattle die; the "speedy death" of the remaining animals considered inevitable (Vol. I., p. 180).

Tsetse on the south bank of the Zambesi, close to and a little to the west of the junction of the Gwai or Quagga R.—

"1st November [1862].—The Tsetse are very troublesome this morning. We did not notice them here in going, nor at the last halting-place. I think there must be "fly" from near the west bank of the Gwai all the way to the Victoria Falls, and beyond to the junction of the Tamalukan or Lingalo's river, near Lake Ngami. Beyond the Gwai to Sinamani's [on the Zambesi, about thirty miles to the east of the junction with the Gwai river] I feel pretty confident there are none. There is no access to the Zambesi with bullock-wagons, nor hunting on horseback, nor with dogs, in these parts, unless with great sacrifices, nor can I find a wagon-road, owing to the broken nature of the ground—rocks, ravines, and mountains—even where there is no 'fly.' . . . Down the Daka river [according to the author's map this is otherwise known as the Luisi, or Luluisi R.: it flows N.E., and joins the Zambesi about 20 miles W. of the Gwai R.], too, I think a road might be found as far as the river [Zambesi], though a district infested by 'fly'" (Vol. II., p. 214).

No "fly" on the south bank of the Zambesi, between the junction of the Gwai R. and Sinamani's, a little to the E. of the junction of the Sebungo R., and *about thirty miles E. of the junction of the Gwai;* "but this may be owing to the density of the population, and the scarcity of buffaloes, which are so much hunted by the Batonga, on account of the ravages they commit in the gardens" (Vol. II., p. 214).

"I think, with a little more knowledge of the country, I could even find a way by which to take a wagon to the Zambesi, but it would probably be impossible wholly to escape the 'fly' in doing so. These pests make their appearance when and where you least expect them. I have not noticed any since leaving the Luluesie, but think they must extend 10 or 15 miles this side of the river [*i.e.* north of the Luluesie] along the mountains" (Vol. II., p. 225).

Tsetse-fly near the Luluesie River, Dec. 1862.—"In the evening John fell in with four buffaloes close by, and shot one of them; but he brought the terrible news that there were thousands of the 'fly' on the one he had killed. I gave orders that the cattle should go out early to graze on the open to the south, while he returns to

the buffalo, and endeavours to catch some Tsetse for my inspection.

"31st December.—John went off early, and soon sent me a fly, which, happily, proved not to be the dreaded Tsetse. The Makalakas say the 'fly' was brought into these parts by the elands from the north, after they had been denuded of their former inhabitants. Heavy rains are said to kill the fly in the season when they prevail. I have learned from the natives that the Tsetse deposit their larvæ in the dung of the buffalo. Snyman tells me, that when he was living at Sekelètu's [another name for Linyanti, on the Chobe R.] a report was brought in that Tsetse had crossed the river to a cattle post. The people in charge fled with the cattle, and Sekelètu sent off a party to burn them back again, firing the grass, and afterwards sent the cattle there again. I do not quite understand this, for I know fields burnt down regularly every year which are still infested with Tsetse. I think the only chance of exterminating them is to keep up constant warfare with the buffaloes until they are driven out. Generally, when they have entered a new country with game, they soon increase and extend themselves farther every year, if the country is suitable" (Vol. II., pp. 249–250).

31. 1868. J. R. Schiner.

"Reise der Österreichischen Fregatte Novara um die Erde:" DIPTERA, p. 311.

Note on a specimen of "*Glossina longipalpis* W." (probably = *Gl. morsitans*, Westw.) from "Central Africa."

32. 1868. ———

"DIE GIFTFLIEGE TZETZE ODER TZALTZALA IN ABESSINIEN" (*Das Ausland*, 41. Jahrgang, p. 192).

A short article in which the identity of the Tsetse with the "Tzaltzala" (Tsaltsalya) of James Bruce* is accepted as proved: it is suggested that since the name "Tzaltzala" has priority, it should be adopted instead of Tsetse. Further references are given to allusions to the "Tsaltsal" in the Bible. In *Job* xli. 7, the word is used in the sense of a fish-spear, therefore it is considered that its transference to the fly is due to the sharpness of the latter's proboscis.

* *Cf.* [1.]

33. 1868. ——

"La Tsetsé, Diptère de l'Abyssinie" (*Recueil de Médecine Vétérinaire*, Vol. 45 (5. Sér. Vol. V), pp. 148–149).—From *L'Opinion Nationale*, Dec. 3, 1867.

[I have not seen this paper.]

34. 1868. ——

"Die Tsetse-Fliege" (*Aus der Natur*, 46. Band (Neue Folge, 34. Band), pp. 783–784).—See also 47. Band (Neue Folge, 45. Band), 1871, p. 447.

[I have not seen either of these papers.]

35. 1868. F. Jaennicke.

An article in *Ergänzungsblätter zur Kenntniss der Gegenwart*, Band III., p. 680.

[I have not seen this paper.]

36. 1869. Karl Mauch.

Mittheilungen aus Justus Perthes' Geographischer Anstalt über Wichtige Neue Erforschungen auf dem Gesammtgebiete der Geographie, von Dr. A. Petermann. 15. Band, 1869, pp. 190–191.

In a letter written in the course of his third journey of exploration from the Transvaal towards Matabele Land, and dated from the Olifant's River, 24° 20′ S. Lat., 31° 37′ E. Long., July 20, 1868,* Mauch says:—"For two days past we have been in the fly (Tsetse) country; neither in the case of the dog nor in that of the ox was it possible to make an external application of Asa fœtida, while an internal application of ammonia was similarly impossible owing to want of fat and meat" (p. 190).

In a further letter from Inyati, dated October 19, 1868, Mauch writes:—"The pack-ox I was obliged to shoot and eat on the Letsobo, although it was seriously injured by Tsetse; the dog died from want of flesh food, or indeed of food of any kind, after I had secured him against the Tsetse by the aid of ammonia. . . ." (p. 191).

37. 1869. John and Mrs. Petherick.

"Travels in Central Africa and Explorations of the Western Nile Tributaries" (London: Tinsley Brothers), Vol. I., pp. 220–221, 222.

* See map: "Originalkarte von C. Mauch's Reisen im Innern von Süd-Afrika" (*Petermann's Mittheilungen*, 16. Band, 1870).

Tsetse-fly at a deserted kraal called Augur, on a low eminence in a clearing in dense forest in which the ground was slightly inundated and covered with rank grass as high as a horseman's shoulders,—*near Adael, in the country of the Rhol Tribe, north-west of Gondokoro.*—"Atchwack tells me that the kraal is now, during the rainy season, untenable from the presence of the destructive Tsetse-fly, here called the *mau*. I had as yet seen none, and hoped our horses would escape, but Atchwack said to-morrow's march might prove troublesome, as the fly was known to exist in the bush in advance of us. The chief, a more intelligent man than ordinary, states that the sting of the *mau*, if in the head or spine of a bullock, causes speedy death, but, if in the body, the animal might linger a week or ten days; but death is inevitable unless a part of the root of a tree called *Tshol goote* is administered internally, and rubbed well into the hide; the animal might then recover. The fly occupies a certain bush, well known to the negroes; at no great distance cattle may graze with impunity; but if they enter the limits occupied by the fly, the consequences are fatal to numbers of the herd, if not to the whole" (pp. 220–221).

[The approximate geographical position of the above locality is 30° 8′ E. Long., 6° 35′ N. Lat., west of the Nile, and north-west of Gondokoro.]

The march was continued on the following day:—"Off at seven A.M., and in ten minutes were following a narrow track through a continuation of yesterday's thick forest.

"Two halts of a few moments' duration, when an eager look-out was kept for the Tsetse or *mau*, several specimens of which were netted; they were precisely similar to the description and sketch given by Dr. Livingstone, but perhaps a trifle smaller. When marching not a fly was seen" (p. 222).

38. 1870. St. Vincent Erskine.

The Natal Mercury, May 31, 1870:—"The meeting of members of the Natural History Association of Natal, held last evening, 30th May, 1870, was most successful. . . . Mr. St. Vincent Erskine's paper on the Tsetse-fly was very interesting, and combated the popular idea that the bite of the Tsetse-fly was destructive to the life of

certain animals, especially the ox, horse, and dog.* Dr. Livingstone's statements on this point were severely criticised by Mr. Erskine, whose theory was that the deaths of the animals were to be attributed more to change of grass or climate than to the bite of such a small fly as the Tsetse. Referring to Dr. Livingstone's assertion that the natives of the Matabele country held the belief that the Tsetse-fly destroyed their cattle, he said that natives of the west of Africa, in whose country the fly was to be found, and who could not keep cattle, did not attribute the destruction of their cattle to the fly."

[Copied from *The Entomologist*, Vol. V., Dec. 1870, p. 217, where the above report is reproduced.]

39. 1870. **Edward Newman.**

NOTE ON MR. ST. VINCENT ERSKINE'S PAPER REFERRED TO ABOVE (*The Entomologist*, Vol. V., Dec. 1870, p. 218).

"Having invariably maintained that the word *Tsetse* implied a disease rather than an insect, and was applied indifferently to all flies that settled on diseased cattle, or indeed on any cattle, and having incurred an overwhelming amount of ridicule for holding so heterodox an opinion, I am delighted to find the opinion held also by a resident, who has every means of obtaining the best information. I have always protested against the importation of a myth like the Tsetse into the domains of science; the mixture of truth and fable in matters of science is always to be deprecated. The Cholera-fly and the *Aphis vastator* are banished from the domain of science; it is abundant time to banish their African congener."

40. 1870. **Karl Mauch.**

"KARL MAUCH'S REISEN IM INNEREN VON SÜD-AFRIKA" (*Mittheilungen aus Justus Perthes' Geographischer Anstalt über Wichtige Neue Erforschungen auf dem Gesammtgebiete der Geographie von Dr. A. Petermann.* 16. Band. P. 1).

Letter written from Potchefstroom, on June 30, 1869, describing the author's journey from Lydenburg to Inyati, July 10 to October 17, 1868:—[Translation.]

"The pack-ox, that I took with me from Lydenburg, proved himself the most incapable beast of burden for the long journey. . . . In spite of every attention, he soon

* *Cf.* [52.]

lost flesh, and the consequences of the innumerable bites received day and night from the Tsetse-fly completely finished him. The poison possesses the property of decomposing the blood, and thereby hinders nourishment and relaxes all muscles. When a short day's march south of the Limpopo I found myself compelled to turn him finally to account by eating him. Sal ammoniac—each week a piece the size of a walnut dissolved in water and administered internally—had no visible effect and is consequently no antidote.

"The female donkey, that I bought at Lydenburg for £9, held out better. . . . The main advantage, however, consisted in the fact that the Tsetse could not do her any harm, whether it be that the donkey finds in certain leaves or in the bark of certain trees an antidote against the poison—or that the long hair or the effluvium from the beast keeps the insect off."

At the end of the volume of *Mittheilungen* in which the above remarks appear is a map entitled: "*Originalkarte von C. Mauch's Reisen Im Innern von Süd-Afrika zwischen Potchefstroom und Zambesi* 1865–1869. *Nebst Übersicht aller anderen Forschungen. Von A. Petermann.*" This map shows by means of a coloured band the "Limit of the Tsetse-fly" ("*Grenze der Tsetse-Fliege*") in the vicinity of the Limpopo, and also farther north, to the south of the Zambesi, in Mashonaland.

41. 1871. E. C. Buxton.

The Entomologist, Vol. V., April, 1871, pp. 283–284:—"The plains on the south side of the Lobombo Mountains, towards Delagoa Bay, was the only district where I met with the Tsetse-fly, and immediately below the mountain they seemed more numerous than at a greater distance. The belief of the natives in the dangerous character of the fly is universal; and I never heard any doubt expressed about it among the white hunters, many of whom have come to this district for many years. We were told that if we took our dogs over the mountains they would be bitten by the fly, would go blind in a few days, and die in ten days or a fortnight. The fly, which was pointed out to us as the Tsetse, was very like a small Horse-fly (cleg, as they are called in Lancashire); it was very common,

and answered the description and picture in Livingstone's first book accurately. We were frequently bitten by them: the bite was very sharp, and felt like a red-hot iron run into the flesh, but it did not leave any mark or inflammation. I caught several, but mislaid them somewhere, as I have been unable to find them. The dogs were frequently bitten, and one of them went blind within a week, and died in about a fortnight. The other did not show illness for some time later; and, as we left him with some of our party, knew nothing more about him than that he died. The fly appears only at certain seasons, and in limited localities. The head of a kraal, about thirty miles distant from the point where we found the Tsetse most abundant, told us at that time the fly was not in his district, and pointed to a heifer and some goats, which he said he intended to send away before the fly season came on. There is a general opinion that the fly is connected, in some way, with the larger game, elephants, rhinoceros, etc., and some think that it breeds in their dung; but I never heard of any proof of this. Mr. Erskine was the only person that I met with who expressed any doubt about the Tsetse; but, as I have not seen his paper, I do not know why he doubts it. The fly district nearest to Natal is about twenty days' journey distant. Our horses and oxen we did not take into the fly country at all."

42. 1871. E. Mohr.

"Eduard Mohr's Reisen im Inneren von Süd-Afrika, von den Tate-Goldfeldern bis zum Zambesi und zurück nach Natal, 20. März—5. Dezember 1870" (*Mittheilungen aus Justus Perthes' Geographischer Anstalt über Wichtige Neue Erforschungen auf dem Gesammtgebiete der Geographie, von Dr. A. Petermann.* 17. Band, p. 164).

[Translation.] "Finally at two o'clock in the afternoon of May 25th my waggon reached its most northerly point at 19° 10′ 51″ S. lat., and the manner and method of my journeying thence to the Victoria Falls of the Zambesi now underwent a change. Five nautical miles further to the north the Tsetse-fly was encountered, not in large swarms it is true, but nevertheless, singly, and it

would consequently have been an act of the greatest imprudence to drive the indispensable oxen and the useful horses still further" [cp. 52].

43. 1871. Otto Kersten.

"Baron Carl Claus von der Decken's Reisen in Ost-Afrika in den Jahren 1862 bis 1865" (Leipzig und Heidelberg: C. F. Winter'sche Verlagshandlung), Band II., pp. 83–84, 303, 304.

[Translation.] "Nevertheless the Tsetse-fly (*Glossina morsitans*, Westw.) which is so common in South and North Africa does not occur in the precise territories traversed by us in our journeys to Dschagga, but rather in the Galla and Somali countries (we shall deal later on with the fly and with the devastation brought about by it there); instead of it, however, a representative exists here in the shape of the Donderobo-fly, which is dangerous to donkeys (see Band I., p. 249). Of species of horse-flies (*Tabanus*), which in the North of Africa plague cattle in an often incredible manner, one hears nothing here, probably for the reason that the herds do not pass their time in the sunny plain, but for the most part on shady and cooler hills, whither these bloodthirsty flies rarely stray" (Band II., pp. 83–84).

[Dschagga is the district on the southern slope of Kilima Njaro. The territories passed through between Mombasa and this region, according to Map VIII. at the end of the volume, were the country of the Wateita, the coast region from Mombasa to Wanga, and a line from the latter to Dschagga running along the northern boundary of the mountain-region Usambara, Pare, and Ugono. The years in which these journeys took place were 1861–62.]

Tsetse-like, cattle-destroying fly in the vicinity of Manamsunde, a town on the Juba River, not far from its mouth, and just north of the equator. The Juba River enters the sea a little north of Kismayu.

[Translation.] "They [the inhabitants of Manamsunde, chiefly Wasegua] occupy themselves almost exclusively with agriculture; for owing to the occurrence in numbers of a poisonous, Tsetse-like fly, they can keep only goats and sheep, but no cattle" (Band II., p. 303).

Further on (Band II., p. 304), in writing of the Wabuni, a scattered tribe of Galla, of whom there are several settlements on the north shore of the Lower Juba, while they extend as far as 3° S., the author says: —

"Like the Galla and Somali they live chiefly by hunting. Moreover, they keep small domestic animals, but no cattle, since in the territories occupied by them the Tsetse-fly makes this impossible."

44. 1871. E. Newman.

"The Tsetse" (*The Entomologist*, Vol. V., May, 1871, pp. 289–290).

A note criticising E. C. Buxton's remarks printed above [41], which are considered by Newman to refer to *Hæmatopota* (Family Tabanidæ).—"All that Mr. Buxton's note proves is that 'clegs' in South Africa are numerous, and that their bite is innocuous to human beings."

45. 1872. H. M. Stanley.

"How I Found Livingstone. Travels, Adventures, and Discoveries in Central Africa; Including Four Months' Residence with Dr. Livingstone" (London: Sampson Low, Marston, Low, and Searle), pp. 87–91, 213, 330, 354.

Tsetse-fly near Rosako, in Ukwere (about 20 miles inland from Bagamoyo). Three different species of biting flies were met with, and even found in the author's tent. The first, called *Mabunga* by the natives, is about an inch long and evidently a species of horse-fly (*Tabanus*). Stanley's men "unanimously stated that its bite was fatal to horses as well as to donkeys." "This fly, along with a score of others, attacked my grey horse, and bit it so severely in the legs that they appeared as if bathed in blood" (pp. 88–90).

Of the second species of biting fly only one specimen was seen during the author's stay at that particular camp: the description is too vague to admit of its identity being determined (p. 90).

"The third fly, called 'chufwa,' pitched a weak alto-crescendo note, was a third larger than the house-fly, and had long wings. If this insect sang the feeblest note, it certainly did the most work, and inflicted the most injury.

Horses and donkeys streamed with blood, and reared and kicked through the pain. So determined was it not to be driven off before it obtained its fill, that it was easily despatched; but this dreadful enemy to cattle constantly increased in numbers. The three species above named are, according to natives, fatal to cattle; and this may perhaps be the reason why such a vast expanse of first-class pasture is without domestic cattle of any kind, a few goats only being kept by the villagers. This fly I subsequently found to be the 'Tsetse'" (pp. 90–91).

"On the 16th [June, 1871] we arrived at Madedita,* so called from a village which was, but is now no more. Madedita is twelve and a half miles from the Nghwhalah Mtoni. A pool of good water a few hundred yards from the roadside is the only supply caravans can obtain nearer than Tura in Unyamwezi. The Tsetse or chufwa-fly, as called by the Wasawahili, stung us dreadfully, which is a sign that large game visit the pool sometimes, but must not be mistaken for an indication that there is any in the immediate neighbourhood of the water. A single pool so often frequented by passing caravans, which must of necessity halt here, could not be often visited by the animals of the forest, who are shy in this part of Africa of the haunts of man" (p. 213).

"Monday, the 2nd of October [1871], found us traversing the forest and plain that extends from the Ziwani to Manyara†, which occupied us six and a half hours. The sun was intensely hot; but the mtundu and miombo trees grew at intervals, just enough to admit free growth to each tree, while the blended foliage formed a grateful shade. The path was clear and easy, the tamped and firm red soil offered no obstructions. The only provocation we suffered was from the attacks of the Tsetse, or Panga (sword) fly, which swarmed here. We knew we were approaching an extensive habitat of game, and we were constantly on the alert for any specimens that might be inhabiting these forests" (p. 330).

"Buffalo gnats and Tsetse were very troublesome on

* In Unyanzi: approximate position, according to author's map, 34° 1′ E. long., 5° 30′ S. lat.

† In Unyamwezi: approximate position of Manyara, according to the author's map, 6° S. lat., 32° 25′ E. long.; the Ziwani (or pool) is about fifteen miles N.E.

this march * [Oct. 8, 1871], owing to the numerous herds of game in the vicinity" (p. 354).

46. 1873. **F. Walker.**

"Central African Blood-sucking Flies" (*The Entomologist*, Vol. VI., pp. 327–328).

Notes on Stanley's statements about blood-sucking flies, quoted above [45].

The fly called by the native name "chufwa" by H. M. Stanley is considered by Walker to be *Glossina longipalpis*, Wied.

Glossina fusca, Walk., is erroneously stated to be identical with *Gl. longipalpis*, Wied.

47. 1873. **E. Marno.**

"Über den Einfluss der Fliegen (Tuban) und insbesondere der Surrēta auf die Hausthiere Sennaar's" (*Mittheilungen aus Justus Perthes' Geographischer Anstalt über Wichtige Neue Erforschungen auf dem Gesammtgebiete der Geographie, von Dr. A. Petermann.* 19. Band, pp. 246–249).

Tsetse-flies stated to have been brought to the author under the name "Surrēta," with three other species of flies, two of which were true Tabanidæ—by natives in Sennaar, who consider the "Surrēta" to be the cause of the mortality among their cattle in the rainy season.

[The occurrence of a species of *Glossina* in Sennaar needs confirmation: † the fly identified as such by Marno was perhaps a *Stomoxys*, or *Hæmatopota*.]

According to Marno (p. 249), the statement that "in certain parts of Africa at certain seasons domestic animals are killed by the poisonous bites of flies, which in some countries even make the keeping of particular domestic animals impossible" has been constantly repeated since the time of Agatharchides.

Marno speaks (pp. 246–247) of "the Baūda, a small gnat [*eine kleine Mücke*], which is found the whole year through, in damp, swampy lowlands, but occurs in the Charif in myriads, and gives human beings fever by its bite." He proceeds wrongly to identify it with the

* In Unyamwezi: approximate locality, from author's map, 6° 10′ S. lat., 32° 12′ E. long.

† *Cf.* [12].

Tsetse: "This Dipteron, named in South Africa Tsetse, in Sennaar Surrēta, is commonly looked upon as the cause of the perishing of domestic animals in many regions, in consequence of which its evil reputation has since the earliest times extended even to Europe. It is a fact, that in Sennaar in and shortly after the wet season the mortality among human beings and domestic animals is much greater than at other times. . . ." Possibly the insect in question is a malaria-carrying gnat (*Anopheles*).

Marno considers that the bites of flies, whether called Tsetse or Surrēta, under which names the natives include a large number of species, are only one, and "perhaps even a subordinate factor" in causing the mortality among imported domestic animals, which occurs in certain parts of Africa either throughout the year, or only during the Charif, and is actually due to adverse climatic conditions.

48. 1874. **Dr. Grube.**

"Über die Tsetsefliege" (*Ein-und-fünfzigster Jahres-Bericht der Schlesischen Gesellschaft für vaterländische Cultur* (Breslau: G. P. Aderholz' Buchhandlung), pp. 50–51).

Report of a lecture (with exhibition of a specimen of a Tsetse-fly provided by Prof. Loew) delivered by Dr. Grube at a meeting of the "*naturwissenschaftliche Section*" of the Gesellschaft, held October 29, 1872.—A résumé of Livingstone's observations.

49. 1874. **David Livingstone.**

"The Last Journals of David Livingstone, in Central Africa, From 1865 to his Death." Edited by Horace Waller, F.R.G.S. (London: John Murray).

Livingstone's experiment with camels and Indian buffaloes introduced from Bombay.

Mikindany Harbour, north of the mouth of the Rovuma River, March 29–30, 1866.—"The people have no cattle, but say there are no Tsetse-flies. . . . The adjacent country has large game at different water pools, and as the whole country is somewhat elevated it probably is healthy" (Vol. I., p. 15).

"*8th April* [1866].—We spent the Sunday at a village called Nÿangedi [about three miles inland from Mikindany Bay]. Here on the evening of the 7th April our buffaloes

and camels were first bitten by the Tsetse-fly" (Vol. I., p. 17).

"17*th April* [1866].—I fear that my experiment with the Tsetse will be vitiated [it seemed likely that the camels and buffaloes would die owing to their being overloaded by Livingstone's sepoys], but no symptoms yet occur in any of the camels except weariness"* (Vol. I., p. 23).

On the north bank of the Rovuma River, 20*th April*, 1866.—"Tsetse are biting the buffaloes again. Elephants, hippopotami, and pigs are the only game here, but we see none: the Tsetse feed on them" (Vol. I., pp. 24–25).

23*rd April*, 1866.—"Buffaloes bitten by Tsetse again show no bad effects from it: one mule is, however, dull and out of health; I thought that this might be the effect of the bite till I found that his back was so strained that he could not stoop to drink, and could only eat the tops of the grasses. An ox would have been ill in two days after the biting on the 7th" (Vol. I., p. 26).

30*th April*, 1866.—*On the north bank of the Rovuma River, near Nachuchu:* approximate position according to Dr. Livingstone's map, 11° 2′ S. lat., 39° 28′ E. long.—"Buffaloes again bitten by Tsetse, and by another fly exactly like the house-fly, but having a straight hard proboscis instead of a soft one†; other large flies make the blood run. The Tsetse does not disturb the buffaloes, but these others and the smaller flies do. The Tsetse seem to like the camels best; from these they are gorged with blood—they do not seem to care for the mules and donkeys" (Vol. I., p. 30).

4*th May*, 1866. *On the north bank of the Rovuma, west of the N'konya River.*—"The buffaloes were bitten again by Tsetse on 2nd, and also to-day, from the bites of other flies‡ (which look much more formidable than Tsetse), blood of arterial colour flows down; this symptom I never saw before, but when we slaughtered an ox which had been Tsetse-bitten, we observed that the blood had the arterial hue. The cow has inflammation of one eye, and a swelling

* "Dr. Livingstone was anxious to try camels and Indian buffaloes in a Tsetse country to see the effect upon them."—EDITOR'S NOTE.

† Obviously a species of *Stomoxys*: the "other large flies" which caused the buffaloes to bleed must have been horse-flies (Tabanidæ).—E. E. A.

‡ Tabanidæ.—E. E. A.

on the right lumbar portion of the pelvis; the grey buffalo has been sick, but this I attribute to unmerciful loading, for his back is hurt; the camels do not seem to feel the fly, though they get weaker from the horrid running sores upon them and hard work. There are no symptoms of Tsetse in mules or donkeys, but one mule has had his shoulder sprained, and he cannot stoop to eat or drink" (Vol. I., pp. 33–34).

6*th May*, 1866. *On the north bank of the Rovuma.*—"Tsetse again. The animals look drowsy. The cow's eye is dimmed; when punctured, the skin emits a stream of scarlet blood." . . .

"7*th May*.—A camel died during the night, and the grey buffalo is in convulsions this morning. The cruelty of these sepoys vitiates my experiment, and I quite expect many camels, one buffalo, and one mule to die yet; they sit down, and smoke and eat, leaving the animals loaded in the sun."

"7*th May*.—We are now opposite a mountain called Nabungala,* which resembles from the north-east an elephant lying down. Another camel, a very good one, died on the way; its shiverings and convulsions are not at all like what we observed in horses and oxen killed by Tsetse, but such may be the cause, however. The only symptom pointing to the Tsetse is the arterial-looking blood, but we never saw it ooze from the skin after the bite of the gad-fly as we do now.

"8*th May*.—We arrived at a village called Jpondé, or Lipondé, which lies opposite a granitic hill on the other side of the river (where we spent a night on our boat trip), called Nakapuri; . . . One mule is very ill; one buffalo drowsy and exhausted; one camel a mere skeleton from bad sores; and another has an enormous hole at the point of the pelvis, which sticks out at the side. I suspect that this was made maliciously. . . ." (Vol. I., pp. 35–36).

20*th May*, 1866. *On the Loendi R., just above its confluence with the Rovuma.*—"The black buffalo is dead; one camel ditto, and one mule left behind ill. Were I not aware of the existence of the Tsetse, I should say that

* From the map, the approximate position of Dr. Livingstone on this day would appear to have been 11° 8′ S. lat., 38° 52′ E. long.—on the N. bank of the Rovuma.—E. E. A.

they died from sheer bad treatment and hard work" (Vol. I., p. 42).

2*nd June*, 1866. *Locality as above.*—"From the appearance of the cow-buffalo, I fear the Tsetse is its chief enemy, but there is a place like a bayonet-wound on its shoulder, and many of the wounds or bruises on the camels were so probed that I suspect the sepoys." . . .

* * * * *

. . . "the European house-fly chases away the blue-bottle-fly in New Zealand. Settlers have carried the house-fly in bottles and boxes for their new locations, but what European insect will follow us and extirpate the Tsetse? The Arabs have given the Makondé bugs, but we have the house-fly wherever we go, the blue-bottle and another like the house-fly, but with a sharp proboscis*; and several enormous gad-flies. Here there is so much room for everything. . . .

. . . the wild hogs abound and do much damage, besides affording food for the Tsetse: . . ."

3*rd June*, 1866. *Same locality.*—"The cow-buffalo fell down foaming at the mouth, and expired. The meat looks fat and nice, and is relished by the people, a little glariness seems to be present on the fore leg, and I sometimes think that, notwithstanding the dissimilarity of the symptoms observed in the camels and buffaloes now, and those we saw in the oxen and horses, the evil may be the Tsetse after all, but they have been badly used, without a doubt. The calf has a cut half an inch deep, and the camels have had large ulcers, and at last a peculiar smell, which portends death. I feel perplexed, and not at all certain as to the real causes of death"† (Vol. I., pp. 44–45).

* *Stomoxys.*—E. E. A.

† According to Laveran and Mesnil (**XXI.**, p. 47, note 7), Lingard found *Surra* to be fatal to the buffalo in India (duration of the malady 125 and 51 days in two experiments), while Penning found it likewise fatal to buffaloes in the Dutch E. Indies. The prolonged course of the malady in these animals, as evidenced by Lingard's experiments, would seem to show that Livingstone's buffaloes may really have been suffering from Nagana at the time of their deaths.

As to camels, Laveran and Mesnil (*op. cit.*, p. 48) write: "In the dromedary Nagana develops pretty rapidly; in the Asiatic camel the course of Surra is sometimes pretty rapid, and at other times very slow; it may even last three years (whence the name *tei-barsa*, signifying *three years*, given to the malady of camels in certain districts of India)." —E. E. A.

26*th June*, 1866. *Further west, along the south bank of the Rovuma.*—"My last mule died" (Vol. I., p. 61).

10*th December*, 1870. *In the Manyuema country, to the east of the Lualaba R.*—"Lion's fat is regarded as a sure preventive of Tsetse or buñgo.* This was noted before, but I add now that it is smeared on the ox's tail, and preserves hundreds of the Banyamwesi cattle in safety while going to the coast; it is also used to keep pigs and hippopotami away from gardens: the smell is probably the efficacious part in 'Heresi,' as they call it" (Vol. II., p. 87).

10*th August*, 1871. *Near Mamohela, Manyuema country.*—"Lion's fat smeared on the tails of oxen taken through a country abounding in Tsetse, or buñgo, is a sure preventive; when I heard of this, I thought that lion's fat would be as difficult of collection as gnat's brains or mosquito tongues, but I was assured that many lions are killed on the Basango highland, and they, in common with all beasts there, are extremely fat; so it is not at all difficult to buy a calabash of the preventive, and Banyamwezi, desirous of taking cattle to the coast for sale, know the substance, and use it successfully (?)" (Vol. II., pp. 149–150).

10*th November*, 1872. *Near the Kalambo R. at the south-east end of Lake Tanganyika.*—"The donkey is recovering; it was distinctly the effects of Tsetse, for the eyes and all the mouth and nostrils swelled. Another died at Kwihara with every symptom of Tsetse poison fully developed" (Vol. II., p. 247).

With reference to the foregoing passage the editor writes as follows:—"The above remarks on the susceptibility of the donkey to the bite of the Tsetse-fly are exceedingly important. Hitherto Dr. Livingstone had always maintained, as the result of his own observations, that this animal, at all events, could be taken through districts in which horses, mules, dogs, and oxen would perish to a certainty. With the keen perception and perseverance of one who was exploring Africa with a view to open it up for Europeans, he laid great stress on these experiments, and there is no doubt that the distinct result which he here arrived at must have a very significant

* This statement appears to have been obtained by Dr. Livingstone from the Arabs.—E. E. A.

bearing on the question of travel and transport" (Vol. II., p. 247).

16*th November*, 1872. *Near the Aeezy R., at the south end of Lake Tanganyika.*—"After waiting some time for the men I sent back yesterday to look after the sick donkey, they arrived, but the donkey died this morning. Its death was evidently caused by Tsetse bite and bad usage by one of the men, who kept it forty-eight hours without water. The rain, no doubt, helped to a fatal end; it is a great loss to me" (Vol. II., p. 249).

50. 1874. **Carl Mauch.**

"Carl Mauch's Reisen im Inneren von Süd-Afrika, 1865–1872. IV. Das Gebiet zwischen Limpopo und Zambesi und die Ruinen von Zimbabye" (*Mittheilungen aus Justus Perthes' Geographischer Anstalt über Wichtige Neue Erforschungen auf dem Gesammtgebiete der Geographie, von Dr. A. Petermann. Ergänzungsband VIII*, pp. 48–49).

[Translation.] "*The Tsetse Fly.*—A great drawback to those regions is a small fly, in size and shape approaching our house-fly, but somewhat paler in colour, of which the natives assert that a single puncture is sufficient to kill a horse, cow, or dog, while donkeys and goats suffer no injury from it. Only one remedy appears to be effective, and that is based upon homœopathic principles: the fly itself, taken internally, makes the punctures innocuous, as I have seen in the case of a dog, which after administering this remedy I took with me as far as the Lower Zambesi and sent back again perfectly well with those who had accompanied me. In the year 1868, when I had an ox, a she-ass, and a dog with me and made experiments with a solution of muriate of ammonia, the ox and the dog perished, while the she-ass, to which I did not administer any of the solution of this salt, after a few days of rest suddenly attached itself to a troop of zebras that were charging by, and ran off, without my ever being able to catch it again" (p. 49).

51. 1875. **J. P. Mégnin.**

"Mémoire sur la question du transport et de l'inoculation du virus par les mouches" (1 planche) (*Journal de l'anatomie et de Physiologie, &c.* (Paris), XI, pp. 121–133. Also in *Journal de médecine vétérinaire militaire*, Paris, 1875, XII, pp. 461–475).

52. 1876. E. Mohr.

"To the Victoria Falls of the Zambesi." (Translated from the German by N. D'Anvers. London: Sampson Low, Marston, Searle and Rivington.) Pp. 192, 244, 286–287, 290, 352–354.

Beneficial effects of ammonia, administered internally, upon horses apparently suffering from Tsetse-fly disease.

"Jennings' party came to see me every evening. . . . They had just come from the banks of the Ganyana River, near the Zambesi, and three of their horses showed symptons of the Tsetse sickness, the result of the bite of the venomous insect of that name. I therefore administered strong doses of eau de l'huis, or extract of ammoniac; and all I can say as to the results of this treatment is, that none of the horses died" (p. 192).

Goats stated not to suffer from Tsetse-fly disease.—"Goats are especially suited for long journeys; on account of their elastic natures, they can accommodate themselves to any circumstances, live upon any and the scantiest food, walk immense distances, and above all, they never suffer from the bite of the Tsetse-fly" (p. 244).

In Matabeleland, south of the Shangani, May, 1870.—"I marched with the greatest caution, as we might now at any moment enter the district rendered dangerous to domestic animals by the presence of the Tsetse-fly. I generally rode on half a mile in advance of the rest of the party, or some natives reconnoitred in front, so as to announce the appearance of the poisonous insect at once" (pp. 286–287).

May 25th, 1870.—*As above:* from the author's map the precise locality is *nearly due south of Wankies.*—"Bokhis, who had ridden forward on Roland at twelve o'clock, came back at three in the afternoon with the news that the Tsetse were close upon us, and brought half-a-dozen of these poisonous flies, which had settled on his horse's neck, as a positive proof of his assertion. We could not therefore think of advancing any farther with the horses and oxen. Latitude 19° 11′ S. was to be the most northerly point reached by our waggon; and as there was plenty of good grass and water here, we set up a permanent encampment for the animals and their attendants, resolving shortly to press on on foot for the Zambesi, accompanied only by our baggage carriers" (p. 290). [Cp. 42.]

"In the districts recently traversed we had often met with the Tsetse-fly, and in some places swarms had flown out of the bushes, inflicting their sharp burning stings upon every member of the party; but we were now* passing out of its haunts, and its occurrence was rare, although a short distance off there might still be thousands. The insect flies rapidly, and stings as it settles on its victim. The sharp sting penetrates easily through a cotton shirt and flannel vest, but a severe momentary itching is the only effect felt by a man; no evil results ensue. I managed to catch several, which I put into a hollow bird's bone, closing the ends with resin, and subsequently gave them to my friend Dr. Hartmann,† of Berlin, the African traveller.

"Some travellers, Vincent Erskine ‡ amongst others, have recently called in question the fatal results to domestic animals of the bite of the Tsetse; but all the natives of whatever race who have accompanied me on my wanderings were agreed in accounting it poisonous, and not one of them would have driven his own oxen or horses into districts frequented by the *Glossina morsitans*.

"Moffat the missionary, who, accompanied by the chief Mosilikatze, had wished to make his way to the Zambesi in a north-westerly direction from the chief kraal of the Matabeles, had to abandon his design through losing all his oxen in the Tsetse district, and only saved his waggons through the intervention of the chief, who made hundreds of the natives yoke themselves to them, and draw them out of the wilderness" (pp. 352–353).

53. 1877. Dr. Hartmann.

Sitzungs-Bericht der Gesellschaft naturforschender Freunde zu Berlin vom 17. *Juli* 1877, pp. 205–206.

Report of a lecture by Herr Hartmann.—[Translation.] "Herr Hartmann further made some observations on the Tsetse-fly. At his request the late traveller Eduard Mohr had brought home and handed over to him to work out a number of specimens of the true *Glossina morsitans*.§ They had been caught, it was stated, with the hand, by Mohr's people in the neighbour-

* July 6, 1870, near the Denzue R., south of the Shangani: approximate latitude, 18° 55′ 27″ S.—E.E.A.

† *Cf.* [53]. ‡ *Cf.* [38]. § *Cf.* [52].

hood of the Mōsi watunja, or Victoria Falls, of the Zambezi, and had been excellently preserved in a piece of hollow bone, coated with wax. On being taken out they proved to be dried up, it is true, but still supple. The lecturer found among the specimens of *Glossina* in the Royal Entomological Museum here, two of the Diptera collected by the German Loango Expedition, which were likewise determined as belonging to *Glossina*. Besides these there proved to be among the Loango insects forwarded by Herr Falkenstein two more flies preserved in alcohol, which in all respects presented the characteristic features of the true Tsetse (*Glossina morsitans*). On comparison with the Zambezi form all that was noticeable was a slight difference in size. While, for instance, the specimen from the first-mentioned locality was 9 mm. in length, with a wing 10 mm. long, the same measurements in the case of the Tsetse from Loango were 10 and 11 mm. respectively. Moreover, in the case of the former the abdominal bands were not so very dark and yet appeared sharply differentiated one from another, while in that of the latter these markings looked darker and less clearly defined. For the rest, the two specimens agreed in the structure of the proboscis, and in the doubly-feathered arista (characteristic of *Glossina*). The lecturer endeavoured to show this by means of coloured drawings, magnified 100 times, of the heads of the Zambezi and Loango Tsetse. According to information supplied by Herr Falkenstein, the Tsetse on the Loango Coast appears to be innocuous. No single case has come to light there of the death of a domestic animal caused by fly-bites; while on the other hand oxen and such-like animals are seen to perish there from other diseases, which admit of ready diagnosis. This agrees with the views first expressed by the lecturer (*Reise des Freiherrn v. Barnim in Nord-, Ost-Afrika*, &c., Anhang XLI) as to the, if not absolute harmlessness, still only slightly harmful nature of the Diptera known under the name Surrīta (Sorrēta, Surrēta, Serott, etc.), as also of the Tsetse-fly in general. Subsequently the traveller E. Marno expressed himself on the question in a precisely similar manner (*Reisen im Gebiete des blauen und weissen Nil*, Wien, 1874, p. 283).

"Herr Hartmann then stated his intention of making further communications on this subject at one of the autumn meetings."

54. 1877. Rev. Joseph Mullens, D.D.

A New Route and New Mode of Travelling into Central Africa adopted by the Rev. Roger Price in 1876, *described by* Rev. Joseph Mullens, D.D.—*Proceedings of the Royal Geographical Society*, Vol. XXI.

"Reflecting on these things, the Directors of the London Missionary Society, when planning their expedition to Lake Tanganyika, thought it worth while specially to enquire into two points: (1) Could a route be found to the north of the Wámi River, on higher ground, and free from the swampy levels found here and there on the road from Bagamoyo? and (2) Was it possible to employ on the entire line the waggon drawn by bullocks, so common in the colonies of South Africa, and that without risk from the Tsetse-fly?" (pp. 235–236).

*A trial expedition under Mr. Price, with a riding-donkey, and a cart drawn by four oxen, left Saadáni for Mpwapwa (a distance of 200 miles) on June 10, 1876, and arrived and returned safely: no Tsetse-fly were met with.**

"As to the difficulty most feared of all, the Tsetse-fly, which seems to be a trouble on the Bagamoyo road, he [Mr. Price] says: 'I regard the absence of Tsetse between Saadáni and Mpwapwa as settled. I took the four bullocks with me the whole way, and left them at Saadáni on my return, apparently in perfect health. Cattle, sheep and goats are to be met with here and there along the whole route.' Dr. Moffat gives it as his experience that it is the increase of population which destroys Tsetse" (p. 241).

55. 1877. Thomas Baines.

"The Gold Regions of South Eastern Africa." (London: Edward Stanford. Port Elizabeth: J. W. C. Mackay.)

Ammonia as a remedy for horses bitten by Tsetse.—"I once used one pound of carbonate of ammonia, dissolved in a bucket of warm water, to wash four horses during our passage through the Tsetse-fly. I cannot

* *Cf.* however [60].

assert that this saved them, but I have every reason to believe so. Nine or more of our oxen died, but not a single horse" (p. 10).

Some of the hills near the Shasha River, Matabeleland, known to be infested by Tsetse (p. 56).

"The Tsetse is easily known by the manner in which he folds his wings one over the other like a pair of scissors, as we have before observed, giving him an appearance of narrowness and length, differing from other flies which settle with wings half expanded; there are some which close their wings at an angle of forty-five like the roof of a house, but none of these are the Tsetse" (p. 57).

*Tsetse-fly on the Macloutsie River, Matabeleland.**—"On Monday [October] 23rd [1871], we reached the wagons at 5 P.M., and sent word to have the oxen kept away till after dark, we set fire to the grass and to heaps of rubbish to drive away the Tsetse, a few of which we saw. Gee had seen a fly upon one of the horses; he touched the place with ammonia and the animal started with pain—a sign that there was a puncture and that the ammonia had entered it. I had about a pound of carbonate of ammonia, and, dissolving the greater part in warm water, I had all four of the horses washed. We observed some of them flinch as if the remedy had found its way into punctures, and it speaks well for our experiment, that up to the present time, so far as I am aware, not one of those horses has died. I had not enough to wash the oxen, but I sprinkled them with tar-water in hope of keeping the fly off, but without effect" (p. 61).

Tsetse-fly on the Limpopo.—"We crossed [the Limpopo] and outspanned [on the south side] on a place† reported clear of fly, but after Mr. Biles had killed and brought home a pullah, we saw a "fly" on Jewell's hat, but failed to catch it. We brought up all the cattle and horses immediately and rigidly examined them, tied up the horses, posted a kafir to watch every insect that approached them, and fired several shots to recall Gee; in a short time he came followed by a kafir bringing another pullah,

* "Last outspan on Macloutsie River, lat. 21° 59′ 5″, long. 28° 44′ E."

† "Outspan on Limpopo, lat. 22° 35′ 31″, long. 28° 41′ 10″ E., height 1,935 feet."

and I went out to meet him at a distance and make sure that he brought no 'fly' upon his game. We saw one on Plait's fore leg, but could not kill it; we washed the place with ammonia, and saw probably the same fly on Mr. Biles's horse; we tried to catch him with the edge of a knife so held as to cast the narrowest possible shadow a little way from the insect, but the Tsetse was too quick even for this; at last Biles struck him to the ground, and I secured him in an envelope to be sent to London" (pp. 63–64).

A "granite hill covered with bush and infested by the dreaded fly," Nov. 2, 1871, on the south bank of the Limpopo, nearly opposite the "Tslagool Hills (the Silika or Siloquam of the maps)": approximate position, lat. 22° 50′ 4″, long. 28° 22′ 40″ (p. 65).

Tsetse in the Northern Transvaal.—"Friday, Nov. 3rd [1871] . . . four or five men and boys joined us, they told us the pan in front was called Madlala, and a day's journey beyond it was 'Schimmel Paard Pan,' there was fly between them, but no water, and there is fly also beyond Schimmel Paard Pan. But we must leave it before dark so as to be able to get into a definite track, and yet not so soon as to rush into the fly until it has retired for the night. It is a day's journey to Maghaliquain River, through which we must not cross as there is fly between it and Madzalana River, but after this we are past all danger, and reach Matlalas in two days and Makapans in four. From Maghaliquain there is fly to the west, between us and the Limpopo" (pp. 65–66).

"The Matchopong mountains were visible to the north-west, and as they are also seen from the Ba Mangwata road they formed a landmark to test the correctness of our longitude. Our last night's track through the fly country had been about 13 miles, and during the afternoon and evening we made about 10 more. The night was dark and cloudy, preventing any observation for latitude, but affording us additional security against the insect pest" (p. 66).

"On Sunday, November 5th [1871], we inspanned about half-past 5, so as to get into the definite road before dark, and about seven we descended into a sandy tract with dense bush haunted by the Tsetse. . . . At dawn on

Monday we trekked again, a steady shower protecting us as we laboured on through the infested district, and in 10 miles and 3 furlongs we reached the west bank of the Maghaliquain or Fierce Crocodile River, called by the Boers the Nyl. . . . Our cattle would not eat the poor and scanty grass,* but crossed the river to the better pasturage they saw on the other side, but unfortunately the 'fly' was there and we had to drive them back again. . . . After sunset on the 9th we crossed the river and trekked up its eastern bank for some distance, and passing through the last patch of 'fly,' outspanned upon an open plain 9¼ miles from our last camp. . . ." (pp. 66–67).

"We had now cleared the infested parts between the Blauw Berg and the Hang Klip mountains, . . ." (p. 67).

[*Near Nylstroom*].—"I halted also at the farm of Theunis de Klerk, who told me they now knew where to ride their horses with safety between the patches of fly; they also have safe or inoculated oxen and even ride their horses in; they will not tell their medicine, but charge an ox for making a horse safe; they told me they thought the fly was a curse that was being removed from the land" (p. 68).

". . . I was obliged [end of January, 1871] to proceed without delay to Matabililand, where the King Lo Bengula confirmed most fully the concession he had already made me in the Northern Gold Fields, and gave me liberty to come out of his country by a more direct road, southward through the Tsetse-fly country into the Transvaal. This might be considered no great boon, as cattle once 'stuck' by the fly are doomed to almost certain death. But the Tsetse, though occupying large tracts of country, does not completely overspread it, but leaves parts which are known to various hunters, and which serve as channels by which a course may be steered with some chance of escape from the deadly pest. Unfortunately, I could not obtain a skilful pilot, and came in contact with one patch of fly, by whose stings I lost nine oxen, but having a pound of carbonate of ammonia I dissolved it in a bucket of warm water and washed all the horses. I am not prepared to affirm that this was the

* "Drift of Maghaliquain, lat. 23° 27′ 20″, long. 28° 54′ 40″, ninety miles, one furlong, sixty-four yards from the Limpopo."

actual saving remedy; but none of them died, and I think the presumption is in favour of the ammonia" (pp. 79–80).

"We heard from a farmer we met during the day that Andreas Duvenage (commonly called Devenaar) knows of a safe road through the fly, between Blauwberg and Zoutpansberg" (pp. 80–81).

"Duvenage lives 18 miles to the north [of Marabastad] and has the best known road through the Tsetse; he crosses the Limpopo at Commando Drift, meeting only one patch of fly, which he rides through in the night" (p. 84).

"The fly leaves a country if the game is driven out or the bush cut away, but returns if the conditions again become favourable to its existence" (p. 89).

Road from Pretoria to Delagoa Bay.—"Here it may be considered that the descent of the Drakensberg proper has been completed, and the lower ranges of the Makondshwa and Lobomba have to be crossed. The road, however, passing through by a tolerably level poort or valley south of the Umbolosi or Dundar River, and immediately after passing the last range, the Tsetse-fly, fatal to domestic cattle, and the fever, no less deadly to man, await the traveller. Fortunately there is only about 40 miles of this unhealthy country; but the fact should be known, in order that the risk may be guarded against by pushing through it as rapidly as possible, and at night or during a cold day, when the fly is dormant" (p. 108).

"It must be remembered, however, on the other hand, that from the Lebomba (*sic*) mountains to the port, a distance of 30 or 40 miles, lies the tract of low country from which Delagoa Bay derived its not undeserved reputation for unhealthiness. A considerable portion of this strip is infested by the Tetse-fly, and a point to be yet proved is whether this belt of fly is sufficiently narrow to be passed through in one night. . . ." (p. 109).

Appearance of Tsetse-flies; symptoms of the disease in cattle and horses; remedies.

"The Tsetse is little more than half an inch long, and rather more slender than a common house-fly. The abdomen is marked with transverse stripes of yellow and dark chestnut fading toward the centre of the back, so as to give the idea of a yellow stripe along it; the belly

livid white, the eyes are purplish-brown, and the wings, of dusky glassy-brown colour, slip one over the other, just as do the blades of a pair of scissors when closed—so that the Tsetse at rest on man or animal may infallibly be known by this one token.

"No fly which rests with its wings half-expanded, like the house-fly, or closed together like a pent-house roof, can be the Tsetse; but if one is seen in which the wings exactly overlap—one lying flat upon the other—that is 'the fly' . . . its sight and smell seem to be keen; its flight straight and rapid. To speak of either its sting or its bite would convey an erroneous idea. The Dutch colonists say it 'sticks,' and this is certainly more correct, as it first pierces the skin with its lancet, and then injects a fluid (poisonous to oxen, horses, and dogs) to thin the blood before drinking it. Men, mules, donkeys, sheep, goats, and wild game are believed to be unaffected by the virus. I, in common with other travellers, have been stuck time after time with impunity. Mules, partaking of the equine nature, are not always secure from dangers to which the horse is liable, and Mr. St. Vincent W. Erskine doubts the safety of the donkey on the south-east coast.

"My friend, Mr. Henry Hartley, the well-known hunter and pioneer of the gold-fields, has kindly summarised the symptoms exhibited by a fly-stuck ox as under:—

"1st. The hanging of the ears, general languid appearance, sometimes watering at the eyes. 2nd. Roughness of the coat, the hair rising on end. 3rd. Feeding voraciously, even to repletion, without improving the condition, and standing panting in the heat of the day. 4th. Occasional swelling at the gullet. 5th. Continual wasting and pining away (but sometimes an ox may improve in condition, and show no symptom of having been stuck for two or three months, or till the first cold rain falls). 6th. An ox slightly stuck goes on wasting till the skin sits fast on the backbone. After this there is no hope; but if severely stuck he dies before it can take place. Mr. Hartley did not notice running at the nose or other unusual discharge. If the ox is worked he will show weakness in the loins. 7th. When the beast is skinned

after death the puncture of every fly can be seen on the inside of the skin, and on the flesh is a ring of yellow mucus, nearly as large as the palm of the hand, similar to the mark that surrounds the bite of a snake, but smaller.

"A bullock belonging to Christian Harmoe was stuck in May; he worked for 500 miles, then began to show symptoms, and died in September. Some of my own—stuck during the passage through the fly country in September, 1871—worked about 300 miles, and died at Mr. Hartley's in January of the next year."

* * * * *

"Mr. Hartley adds:—'Horses swell about the eyes, nostrils, and testicles, where generally the wounds are most numerous, they pine away, and their hair stands on end, or is reversed; cold rain also hastens their death.' My friend, the late Joseph Macabe, being incredulous, deliberately rode a valuable hunter right into an infested tract, and returned to the outspan, where his steed died in a few hours, and the pool is now called Schimmel Paard's Pan, or the pool of the dapple grey horse. Mr. Hartley's splendid grey elephant charger, 'Camelbuck,' died twenty days after he was stuck; ammonia was applied, and he was led to stand in cold water, which is said to be sometimes effectual, but in vain. My own horse, 'Vegtmann,' stuck, I believe, in October, 1869, travelled more than 1,100 miles, and died early next year in Pieter Maritzburg. Dogs pine and waste as oxen do. We lost some, but one, a rough hairy bitch, seemed recovering; the new hair that grew on places where she had apparently been stuck was coarser and greyer than before.

"The fly is extremely local, and extensive districts in which it prevails may be passed through by the aid of guides, who know the 'patches' of fly, just as a pilot knows the shoals of an estuary; but it shifts with the migration of game, and, therefore, the knowledge of the guide ought to be recent.

"The hunters endeavour to keep it from their road, in Matabililand, by burning the dry grass, as they come out at the end of the season. And when the Boers made their celebrated 'Commando path,' they destroyed the bush for several hundred yards on either side as they approached

the Limpopo. If a belt of fly cannot be avoided, it may be passed through, if not too wide, in the night, or on a cold rainy morning; but the last is a dangerous experiment, for should the sun break through the clouds it rouses the insects with increased vigour and activity from their torpor; and it is well known that on a hot day all poisonous creatures are more virulent and deadly."

* * * * *

"I am not aware that any certain remedy is known. The native doctors inoculate oxen by giving them the fly itself, mixed with herbs. The poor beast suffers dreadfully, and is brought almost to the point of death, but when it recovers is believed to be Tsetse proof.

"All young animals, while living on milk, are safe. Some of the tribes living on the borders drive the calves into the fly during the day, and bring them out to be suckled morning and night. This is supposed also to render them secure during the rest of their lives.

"It would be a great boon if any composition capable of being sprinkled or syringed over the animals—innocuous to them and disgusting to the fly—could be discovered; tar, ox dung mixed with milk, the kidneys of the meer kat, etc., have been recommended, but carbolic acid would perhaps be more effectual, diluted with water, and applied by syringe or the rose of a watering-pot.

"Mr. Hartley tried a decoction of the bark of the roots of the wittegaat boom, or motlopre, I believe, with some success; and there are Boers who profess to be able to cure an animal recently stuck. Their fee is one good ox for saving a horse.

"While passing through the fly, in 1871, I mixed about a pound of ammonia with a bucket of warm water, and washed all four of our horses. We noticed that they flinched, probably as the liquid entered the punctures. None of them died; and though I would not affirm on one experiment that the ammonia saved them, I think it highly probable such was the case.* Unfortunately, I had not enough to wash the oxen with. We tried to

* "June 27, 1874. I hear that during last season a hunter, on entering the fly country, dosed or washed his horses continually with ammonia, and has brought them all out safe, but very weak, probably from the combined effects of the poison and its antidote."

restore tone to the blood with muriate of iron when I reached Mr. Hartley's farm, but it was then too late.

"Mr. Saunders, of Maghaliesberg, saved a horse with Croft's tincture of life, which contained ammonia, and two oxen with Perry Davis's pain killer. They stood for three or four days with foam issuing from their mouths, as if the poisonous matter were being thus ejected. After this they began to eat voraciously and recovered their condition. Perhaps if milk could be given to animals as soon as they are stuck they might recover" (pp. 151–154).

"The dangers, however, of the Delagoa Bay route [to the Transvaal gold-fields] would be more efficiently met by the construction of a good road, with the bush cleared away as far as possible on either side, in the fly country, leaving the unhealthy lowlands as soon as possible, and climbing any elevated ridge, the course of which (even at the cost of considerably increased distance) might be followed to the highlands, so that man and beast might be as little as possible exposed to fly or fever" (p. 154).

"In the *Colonist* of June 19th we are informed that Mr. Isidore Alexandre has brought an ox wagon down from the gold-fields to Delagoa Bay in nine days, and others are to follow. There has been no loss among the oxen. I would fain hope the best for Mr. Alexandre, but I shall watch with great interest the future history of these animals. We know that in cold weather the fly is less virulent, but it never ceases to be dangerous" (p. 155).

"The Gold Regions of South-Eastern Africa." Distances and Routes.

"Tables of Distances by Trocheameter—Latitudes and Longitudes (astronomical or computed)—Heights above the sea-level, and other observations, from Port Natal to the Ganyana River, *viâ* Hartley's, or the Potchefstroom, Rustenberg, and Tati route, free from Tsetse-fly; and return route through the Fly country, *viâ* Magholiquain River and Makapan's Poort. During the years 1869, 1870, 1871, and 1872. By Thomas Baines, F.R.G.S." (p. 164).

"The Tsetse-fly extends from south-east of Maghaliquain [River] to Shasha" (p. 171).

"Limpopo River, south side . . . Lat. 22° 37′, long. 28° 38′. Height in feet, 1,935. Granite quartz, palms, thorns, castor-oil plant, Tsetse-fly" (p. 171).

"Pass between Blaaweberg and Zoutpansberg through Fly country, probably to Commando Drift, Limpopo River, enquire for safe road of Der Venage or other hunters. . . . Lat. 22° 20′, long. 29° 10′. Height, 1,700 or 1,800" (p. 173).

Tsetse-fly (and fever) stated to be prevalent to the south-east of Pretoriaskop, Transvaal: approximate position, lat. 25° 12′, long. 31° 31′ (p. 182). [Period to which this refers is probably the early 'seventies—up to 1874.]

"The Tsetse-fly abounds in this low country nearly to Pretoriaskop. Mr. Macdonald's expedition lost, I think, 114 oxen, and Mr. Arrowsmith reports a loss of fourteen. Donkeys are generally safe, but not quite so here" (p. 183). [This refers to a route from Pilgrim's Rest to Delagoa Bay.]

Patch of "fly" referred to in the author's itinerary of his route from Walvisch Bay to Victoria Falls and Logier Hill, Zambesi River, near Matietsie River; latitude 18° 20′ (p. 187).

Broad red sand hill, with mopani trees, and infested by fly; latitude 18° 30′ (near Victoria Falls) (p. 187).

56. 1878. **H. M. Stanley.**

"Through the Dark Continent, or The Sources of the Nile, Around the Great Lakes of Equatorial Africa, and Down the Livingstone River to the Atlantic Ocean" (London: Sampson Low, Marston, Searle and Rivington).

Gad-(horse-)flies and *Tsetse on the numerous low islands below Rubunga, on the Congo*, and attacking the members of the author's expedition descending the river in their canoes and boat, February, 1877 (Vol. II., p. 292). Position of Rubunga, according to the author (*ibid.* p. 281), 1° 40′ 44″ N. lat., 21° 4′ E. long.

From the author's subsequent remarks, the expedition seems to have been attacked by horse-flies and Tsetse during its further course among the islands in this portion of the Congo, at least as far as 1° 22′ 15″ S. lat.: February, 1877 (Vol. II., p. 310).

57. 1878. F. B. Fynney.

"The Geographical and Economic Features of the Transvaal, the New British Dependency in South Africa" (*Proceedings of the Royal Geographical Society*, Vol. XXII.).

"Zoutpansberg forms with Waterberg the northern boundary of the State, lying to the N.E. . . . Many parts of this district, as well as Waterberg, are infested with the Tsetse-fly; but there is scarcely need to attach so much importance to this fact as is commonly done, because the fly is merely a temporary and ephemeral scourge, and always disappears with the large game.

"Many parts, which six years ago were known as Fly country, are now entirely free, and therefore it may be fairly hoped that the extinction of the pest is only a matter of time" (p. 120).

58. 1879. J. J. Drysdale, M.D.

"On the Germ Theories of Infectious Diseases" (*Proceedings of the Literary and Philosophical Society of Liverpool*, No. XXXIII., p. 13, note).

An early suggestion pointing to the true part played by the Tsetse-fly in connection with fly disease. After referring to the then recent discovery by Dr. Manson of the transference of *Filaria sanguinis* by mosquitoes, the author adds the following footnote:—

"It is possible that we have here an explanation of the destructive power of the Tsetse-fly, for it may be the intermediate host of some similar blood-parasite; or it may be the carrier of some infective poison. It is highly improbable that any mere poison or venom should exist so powerful as to cause the death of a large animal in such small dose."

59. 1879. Captain J. F. Elton.

"Travels and Researches among the Lakes and Mountains of Eastern and Central Africa" (London: John Murray), pp. 278, 404.

August, 1877.—Tsetse abounding at Livingstonia, at the south end of Lake Nyasa (p. 278).

Still a question whether the deaths and sickness of cattle on the Unyamyembe route from the coast to Lake

Tanganyika is "due to Tsetse or to the rank wet vegetation of the lower country" (H. B. Cotterill, in above volume, p. 404).

60. 1879. **Sir Rutherford Alcock, K.C.B.**

Address on the Opening of the 48th Session of the Royal Geographical Society, November 11, 1878 (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. I., p. 2).

Destruction by the Tsetse-fly "on the road to Mpwapwa" of the draught cattle belonging to a party sent by the London Missionary Society to Lake Tanganyika. [*Cf.* **78.**]

61. 1879. **Dr. Laws.**

"Journey along Part of the Western Side of Lake Nyassa, in 1878" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. I.).

Cattle-destroying fly (? Tsetse) *in the valley of the Limpassa (an affluent of the River Lucia, which flows into the Lake at Makambira).*

"One place here, called Mudaye, presents what is probably the best place we have seen in the district, with an elevation of 800 or 900 feet above the lake. There is the great drawback, however, that a fly is reported to exist in the lower part of the plain, which if not the Tsetse, resembles it by its bite killing cattle. The specimen of the fly shown to us was not the Tsetse, but belongs to the blood-sucking tribe. The Mangone had at one time lived in the hollows, but removed further up the hills to save their cattle" (p. 317).

62. 1879. ——

"The Dar-es-Salaam Road" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. I. (Geographical Notes), p. 129).

Tsetse-fly absent from the first forty miles of the road inland from Dar-es-Salaam.

"Mr. Beardall, formerly of the Universities' Rovuma Mission, left England, on the 28th of November [1878], to take charge of the works in connection with the road now making from Dar-es-Salaam to the interior of Eastern

Africa. . . . Eight out of the ten bullocks brought from Madagascar are doing good service on the road, and it is therefore clear there is no Tsetse-fly on the forty miles already traced of the route; . . . ."

63. 1879. ——

"The African Insect Scourge. The Tsetse-Fly" (*The Journal of Applied Science*, Vol. X., May, 1879, pp. 74–75).

[I have not seen this paper.]

64. 1879. Lewis Hornor.

The Times, Feb. 25, 1879.—A letter recommending the Boer method of crossing fly-belts at night (quoted by Westwood in Oates' "Matabele Land and the Victoria Falls," First Edition (1881), Appendix, p. 364; Second Edition (1889), p. 388).

"Having hunted in the African fly country and seen many horses and oxen die of the bite, against which no external application is, I firmly believe, any safeguard, I venture to call attention to the precautions adopted by the Boer elephant hunters in the interior. The Tsetse inhabits narrow and clearly defined strips of country, familiar to all natives, and readily evident to strangers. On approaching one of these 'fly belts' (so called) a halt is made, and inspanning again at sundown the Boer treks through at night in safety. I only remember one case of mishap, when, in crossing a belt near the confluence of the Chobé and Zambesi, two or three oxen out of nearly forty were bitten, and that, if my memory serves me, on a bright moonlight night."

65. 1879. F. Karsch.

Zeitschrift für die gesammten Naturwissenschaften, LII. Band, p. 381.

Glossina longipalpis, Wied. taken at Chinchoxo, in Loango, by Dr. Falkenstein.* [Chinchoxo, or Tschintschōtscho, is a town on the coast about 100 miles north of the mouth of the Congo.]

65A. 1879. Dr. J. Falkenstein.

"Die Loango-Expedition." Zweite Abtheilung, (Leipzig: Paul Frohberg), p. 84.

* *Cf.* [65A and 80].

Eleven oxen, purchased in Loanda and taken to Tschintschōtscho to be trained as baggage-animals, soon died (1875). But although several specimens of a species of Tsetse-fly were taken there, the deaths of the animals are not considered to be due to the insect, but rather to change of climate and food, since the symptoms were carefully watched throughout the course of the disease.*

66. 1880. **Capt. F. F. Carter.**

"Captain Carter's last March in Central Africa" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. II., 1880, p. 762).

[Extracts from the diary of the late Capt. F. F. Carter, who conducted the Belgian Elephant Expedition from Dar-es-Salaam to Mpwapwa [*cf.* 79]. Capt. Carter was killed at Kasogera, on June 23rd or 24th, 1880, soon after starting from Karema, on Lake Tanganyika, on his return march to the coast.]

Tsetse-fly near Karema (German E. Africa).

"On 13th June [1880] started together from Karema. . . . On 15th . . . reached place called Marimba, where ground is marshy, lots of *bad* water; food for elephants in dry season; once a large village, now deserted; Tsetse-fly in thousands."

* * * * *

"*Thursday, 17th.*—Bitterly cold morning; passed through a sort of gorge in the mountains; very heavy dews at night, and grass high and very wet, showering dew on us; . . . Thousands of Tsetse, nearly driving us mad. On passing River Fuma we entered Mongway district, this river dividing Fipa from it."

67. 1880. **Dr. Emil Holub.†**

"Journey through Central South Africa, from the Diamond Fields to the Upper Zambesi" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. II., p. 174).

(See author's map, inserted after p. 400, *op. cit.*)

Tsetse-fly in Matabele Land (1875), to the south of the Victoria Falls, east of "Sandy Pool Plateau" (approximate position 19° 10′ S. lat., 26° E. long). The author

* *Cf.* [65 and 80]. † *Cf.* [75].

is proceeding north-west, to Panda ma Tenka and the Chobe.

"I thus entered a high sandy plateau, a thickly wooded forest where there are no rivers, but thousands of pools, the greater number of which only contain water after rain, and which I named the 'Sandy Pool Plateau.' Where I crossed, it is 102 miles in width. . . . Here in coming from the south we met with buffaloes, elephants, and rhinoceroses for the first time. . . . I found the limits of the Tsetse were from ten to fifteen miles east of the direction which I took."

* * * * *

"[*August*, 1875.]—Eight miles from Pandama [*i.e.* Panda ma Tenka] I crossed the first boundary of the Tsetse, coming afterwards to a part free from Tsetse, and the second time entering a part infested by it about twenty-one miles south of the Chobe Junction" (p. 174).

68. 1880. G. Macloskie.

"The Proboscis of the House-Fly" (*The American Naturalist.* Vol. XIV., pp. 153–161, figs. 1–3).

69. 1881. The Right Hon. Sir Bartle Frere, Bart., G.C.B., G.C.S.I., &c.

"On Temperate South Africa" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. III.).

Mode of crossing the Fly-belt south of the Zambesi, near the Victoria Falls.

"Mr. Humphery, a young traveller now present, who visited the Victoria Falls a few seasons ago, gives the following account of the mode of passing the Tsetse-fly belt on the south bank of the Zambesi about seventy miles above the Falls.

"Leaving the last halting-place free from Tsetse in the evening, they travelled all night to avoid the insect, and before morning reached a narrow strip of country free from fly but without water, though there was grass for the oxen. The next night a shorter march brought them to the river in time for the oxen to drink and return back to the spot free from fly before daylight.

"It must be remembered that the Tsetse-infected tract varies from year to year with the movements of the

large game, and according to the nature of the season; and that the area where the fly is fatal appears to be diminishing rather than increasing" (p. 14).

In the discussion on Sir Bartle Frere's paper (read November 22, 1880)—"Sir Fowell Buxton observed that the subject of Sir Bartle's paper could not fail to be of great interest to all who felt anxious about the continuance of the work of exploration in Central Africa. . . . One matter of some hopefulness was the fact that the Tsetse-fly seemed to be gradually receding before the advance of civilisation. Efforts had been made to construct a road from the coast into the interior, and the grand attempt made by the King of the Belgians to introduce the elephant as a beast of burden should not be forgotten. Some attempts had been made also to introduce wheeled traffic, though the fly had hitherto stood in the way. He could not, however, but hope that better success was in store in the future, since it appeared that the Tsetse scourge disappeared wherever the large game was driven back.

"Sir Bartle Frere said with regard to the possibility of getting across the fly-belt, the testimony of the chief hunters and traders went to show that the Tsetse certainly did, to a great extent, follow the movements of the great game; and also that as the country became better known, particular points were discovered by the guides where even during the day-time, in the immediate vicinity of the bush infested by the fly, there were cleared spots where the fly never touched a horse, and that those who had been much in the fly districts were able to discover routes through the infested belts by which horses could with great care be conveyed; and of course if that was the case on a small scale, it might gradually be that the means of carrying animals subject to be bitten by the Tsetse through the infested belt would increase. Mr. Humphery had told him that traders had conveyed a wagon across the river [Zambesi], and it had been purchased by a chief on the other side, but unfortunately he was not beyond the region so fatal to oxen. However, there appeared to be very little doubt that there was a region perfectly free from the fly at no great distance on the northern bank, and within practicable reach" (p. 19).

70. 1881. **Père Duparquet.**

Proceedings of the Royal Geographical Society and Monthly Record of Geography. New Monthly Series, Vol. III., p. 43 (Geographical Notes.—The River Okavango).

Tsetse-fly on the Okavango, or Tioge or Tonke River, at its junction with Lake Ngami.—"He [Père Duparquet] would have preferred, he says, to begin his description from Lake Ngami, instead of devoting his attention to the portion of the river between Libêbé and the country of the Amboellas (in about 16° S. lat.), but few particulars were procurable, as, owing to the presence there of the *Tsetse*-fly, this part of the river is but little frequented."

71. 1881. ——

"Dr. Kirk's Visit to the Dar-es-Salaam District in East Africa" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography*, Vol. III., pp. 308–309 : Geographical Notes).

Belt of Tsetse-fly wider and more continuous inland from Dar-es-Salaam than farther to the north; fly found 40 miles from the coast.—"Early in the present year Dr. Kirk made an interesting journey, in company with Captain Foote, R.N., along the road recently made at the private cost of Mr. Mackinnon and Sir Fowell Buxton towards the interior of East Africa from Dar-es-Salaam. . . . The presence of the Tsetse-fly in the country 40 miles from the coast further renders the employment of horses or bullocks as beasts of burden out of the question; the belt of fly-country is, in fact, here wider and more continuous than it is further to the north."

72. 1881. **Major Serpa Pinto.**

"How I Crossed Africa: From the Atlantic to the Indian Ocean, through Unknown Countries; Discovery of the Great Zambesi Affluents, etc." Translated from the author's manuscripts by Alfred Elwes (London: Sampson Low, Marston, Searle and Rivington), Vol. II., p. 81.

October, 1878.—*On the right bank of the Zambesi, between Itufa and Sioma, Barotseland* (approximate geographical position, 16° 30′ S. lat., 23° 30′ E. long) :—

"I started whole flocks of heathcocks, quails, and

Guinea fowl* (*Numida meleagris*), which were in greater numbers than I had hitherto seen in Africa. I also found, to my sorrow, that the Tzee-tzee-fly was quite as abundant as the birds; it troubled me excessively in the forest with its sharp sting, which, however painful, is not dangerous to man; and these insects were so numerous and pursued me so inveterately that, after I had again got into the boat, I had for some time to do battle with them."

73. 1881. F. Oates.

"MATABELE LAND AND THE VICTORIA FALLS" (London: C. Kegan Paul & Co.), 1st edition; Plate G, fig. 2; Plate H, figs. 5, 5a, 5b.

Tsetse-fly at the Victoria Falls (1873).—"He [the Hon. G. C. Dawnay] showed me some little sketches he had made [of the Victoria Falls], but said it was almost impossible to draw on account of the flies. The Tsetse-fly, which kills everything, except men, wild beasts, and donkeys, swarms there, and bites so furiously that your hands and face are puffed up in no time" (p. 38).

"He [a Transvaal Boer, named Lee] has tried donkeys in the Tsetse-fly country, but the fly has always killed them" (p. 48).

Notes by J. O. Westwood (pp. 363–365). See **74**.

74. 1881. J. O. Westwood.

Oates' *Matabele Land and the Victoria Falls*, 1st ed., Appendix, pp. 363–365, Plate G, fig. 2; Plate H, figs. 5, 5a, 5b (2nd ed., 1889, pp. 388–389, Plate VII., fig. 2; Plate IX., figs. 5, 5a, 5b).

Copy of the letter by Lewis Hornor, in the *Times*, of Feb. 25, 1879 (see **64**) (1st ed., p. 364).

"The African traveller Hildebrandt recommends strongly, in the *Korrespondenzblatt der afrik. Gesellschaft*, the use of petroleum for those travelling in the tropics, as a protection against insects. Occasional applications to the face and hands ensured entire freedom from mosquitoes, and the same method sufficed to preserve horses and cattle against the deadly attacks of the Dondorobo gad-fly, which so often cripples the movements of the explorer" (1st ed., p. 364).

Coloured figure (enlarged) of *Gl. morsitans*, and details of antenna, mouth-parts, and last joint of tarsus.

* By an obvious slip the word here in the text is "partridges."—E. E. A.

75. 1881. **Dr. Emil Holub.***

"Seven Years in South Africa: Travels, Researches, and Hunting Adventures, between the Diamond-Fields and the Zambesi (1872–79)." Translated by Ellen E. Frewer (London: Sampson Low, Marston, Searle and Rivington), Vol. II.

[August, 1875.] "In the evening we halted facing a wooded ridge, which would have to be crossed at night, on account of the Tsetse-fly with which it was infested. . . . The night was dark, and we could scarcely see ten yards in front of us, but shortly after two o'clock we ventured to start, and got safely through the wood without any inconvenience from the Tsetse-fly, finding ourselves at dawn on the the plain called the Gashuma Flat" [near the Panda ma Tenka River] (p. 105).

Portion of route to the Victoria Falls near the Gashuma Flat known to be infested with Tsetse (p. 183).

Tsetse-fly near Panda ma Tenka: havoc caused by it amongst bullocks (pp. 373–374).

76. 1881. **F. C. Selous.**

"A Hunter's Wanderings in Africa" (London: Richard Bentley & Son).

Umziligazi's cattle decimated by the Tsetse-fly (in Matabele Land, north of Buluwayo), p. 31.

"The 'Tsetse' fly has now come up to the Jomani [a little river in Mashuna Land], so that hunters of late years have had to travel by another road more to the south" (p. 34, note).

"In the day-time, too, 'Tse-tse' flies, whose numbers increased daily as the season advanced, were very troublesome [on the Lower Chobe River]. Nowhere does this virulent insect exist in such numbers as to the westward of the Victoria Falls, along the southern bank of the Zambesi and Chobe. It is usually found in great numbers near the river, becoming scarcer and scarcer as one advances inland, till at a distance of a few miles it disappears, except in some particular patches of forest. Along the water's edge they are an incredible pest, attacking one in a perfect swarm, from daylight till sunset, and, without a buffalo or giraffe tail to swish them

* *Cf.* [67].

off, life would be unendurable. The well-known African traveller, Andersson, says their bite has been not inaptly likened to that of a flea. My experience is that it is far more severe, and that about one in every ten bites (that perhaps touches a nerve) closely resembles the sting of a wasp or bee, as it will cause one when seated to spring up as if pricked with a needle. As they are possessed of a long probe, a thick flannel shirt offers no protection against these most abominable of all created insects—direct descendants, no doubt, of the flies that plagued Egypt. Though, during 1872–73, I had hunted elephants on foot in fly-infested countries, yet never had I met with them in sufficient numbers to cause much annoyance; but along the Chobe river, during the months of September and October, hunger, thirst, fatigue, and all the other hardships that must of necessity be endured by the elephant-hunter, sank into insignificance as compared with the continuous, unceasing irritation caused by the bites of the 'Tse-tse' flies by day, and three or four varieties of mosquitoes by night. What a glorious field lies open there for an enthusiastic entomologist! I think that this plague of 'Tse-tse' flies, along the Chobe and Zambesi, is due to the enormous numbers of buffaloes that frequent their banks, as they always seem very partial to those animals. The bite of this remarkable insect, as is well-known, though fatal to all kinds of domestic animals, is innocuous to every species of game, and to man. A general belief exists, that amongst domestic animals, the donkey, dog and goat are exceptions to this rule, but this is a mistake, for I have seen all three die from the effect of its bites. That all the natives living in the 'fly' country possess both dogs and goats I admit, but these have been bred there from generation to generation, and have become acclimatised, whereas, if you take either a goat or a dog that has been bred outside the 'fly' country, into a district where the 'Tse-tse' is found, it will die in nine cases out of ten, and the original progenitors of the animals the natives now possess were no doubt such exceptions to the general rule. Even now, the natives told me, out of a litter of pups, born in the country and of acclimatised parents, some always die of 'fly' symptoms. The 'Tse-tse' fly is about the same size as a common

horse-fly, of a dull grayish colour, with bars of a pinky tinge across the body; its wings, however, do not lie in the form of a pent-house, but are like those of an English house-fly, only longer. Animals, such as horses and oxen, that have been bitten by the 'fly' during the dry season, usually live on until the commencement of the rains, but seldom survive long after the first shower has fallen. It often happens that when hunting with horses outside but close to the 'fly' country, one is led in the ardour of the chase into an infested district; if such is the case, and it is uncertain whether the horse has been bitten or not, the truth can be ascertained by pouring a few buckets of water over him, when, if he has been 'stuck' (as hunters call it), his coat will all stand on end, like that of a lung-sick ox. On several occasions horses have been purposely taken into parts of the 'fly' country, where elephants were known to be plentiful, in the hope that, by their aid, their owners would be able to shoot enough ivory to compensate for the loss entailed by their inevitable death; for, of course, in tolerably open country a man ought to be able to kill very many more elephants on horseback than on foot. My comrade, W., once made an experiment of this sort, and he informed me that at the end of two weeks his horse grew too weak to hunt with, and at the end of three could not carry him at all, though it did not die for some time afterwards" (pp. 130–132).

"The forest being pretty open, and the moon about full, we got along well enough, and at last, about midnight, we struck the river at a point at least twelve miles from our camp, which we did not reach much before daylight. I think it is usually believed Tsetse-fly will not bite at night; but along the Chobe river (where they swarm), and by moonlight, I can feelingly say that this is a mistake. They kept flying up from the ground on to my naked legs, and bit as furiously as in the day-time; and, judging from the deep curses and loud slaps behind me, I had no doubt they were paying similar attentions to my Kaffirs" (p. 154).

Tsetse-fly found on the Umbila River, Mashuna Land: three flies caught in cattle kraal belonging to the author's camp, and "fly" seen not a mile from the wagons.—

"Of course we thought that all our oxen and the two horses we had left at the wagons were 'fly-stuck,' and cursed our luck accordingly; but we were eventually very agreeably disappointed, for we did not lose a single ox, though two of mine and one of Wood's showed evident signs of having been bitten, becoming very thin and running at the eyes. They were all young animals, however, and at last pulled through, though one of mine did not commence to make flesh again for more than a year. These facts convinced me that it takes more than one fly-bite to kill an ox or any other animal, and that recovery from Tsetse bite is possible when the blood has not been too strongly impregnated with the poison" (p. 349).

77. 1881. Dr. B. F. Bradshaw.

"THE TSETSE-FLY" (*The Transactions of the South African Philosophical Society*, Vol. II., Part I., pp. 51–55).

The Tsetse-fly "is very tough, and bears a good squeeze without being any the worse for it."

"It inhabits the forest country on the north bank of the Zambesi in great numbers, and is found in three belts along the Zambesi road. Commencing at the first, is a belt along the Zambesi and Chobe rivers, varying in width from eight to twelve miles, and is more numerous in some localities than in others, according to the amount of game, being fewer where game is scarce and *vice-versâ*; is much more plentiful during the winter months, namely, from April to end of September, than during the summer. The next belt of fly is about fifty miles from the river, along the wagon road, in a southerly direction, between it and Panta ma Tenka, is about six miles wide and eight miles from the trading station at Panta ma Tenka. Sometimes you may pass in the day-time and see no fly, at other times you will notice many. This part of the country is one of those sandy ridges covered with forest so common in the country. About six inspans, or forty-five miles from Panta ma Tenka, is the third belt of Tsetse; the wagons generally inspan after sunset, and trek for about three hours, then tie up the oxen and let them sleep for a couple of hours, inspan again for four hours, and we consider ourselves past the region of the fly, which must be twelve or thirteen miles wide; it is also very uncertain

here, one time very numerous, at another none to be seen. The game also is generally very scarce here. The country consists of heavy sand and forest, being a portion of the sandy pool plateau. The Bushmen have told me that the fly breeds in the buffalo droppings, and it seems as if there was some truth in it, because where the buffaloes have been driven away in certain tracts, the fly has almost disappeared. It is not found on the north bank of either the Zambesi or the Chobe rivers, close to the water where there are flats. 'Wankie's' people, the Mashapatans, have informed me that before 'Mosilikatze' drove them across the Zambesi, the hilly tract of country between the 'Gwai' and Daka rivers had no Tsetse, was thickly inhabited by three tribes, namely Mashapatans, Matongas, and Batokas, and that they had plenty of cattle, but since the country became uninhabited and overrun with game, it has become one of the great strongholds of Tsetse, extending from the Zambesi river for at least sixty or seventy miles in a southerly direction—one effect produced by the Zulus' love of rapine and slaughter.

"It bites throughout the day, except when it rains, and during part of the night if warm; in fact, I consider it dangerous to travel at night with cattle or horses, until it begins to grow cold towards the middle of the night, as I have been bitten often until past 11 P.M. It is very cunning, always darting, if watched, behind one's back, and if much persecuted with a fly-duster, darts to the grass or bushes, but soon returns to the attack. It will follow, for miles, fresh meat, or natives, but soon returns within its bounds. Tsetse will not stay long in a camp, after fires are lighted, although numerous all round. The Kaffirs have said to me, when much troubled by the fly in camp, 'Make a fire and they will go away.' I found the experiment to succeed. Its buzz is peculiar and not easily forgotten" (pp. 51–52).

"All domestic animals perish if bitten, sooner or later, with the exception of the goat; the donkey seems to resist it longest. Dogs are taken into the fly district by the Bushmen when pups, and are allowed to suckle the mother, and at the same time given as much fly to eat as can be captured for them. The mother in this case dies and the pups live and grow up, but are the most miserable

looking objects I ever saw belonging to the canine race—emaciated, small, and the hair standing straight up all over them. Goats, like all game, get fat and do not seem to mind it. In fact, the Kaffirs keep large flocks in the fly districts near the 'Victoria Falls,' on the north bank of the river.

"Unless bitten by several Tsetse, animals do not show any symptoms in particular until the rains fall. Then oxen especially get emaciated and weak rapidly, much weaker than they would be if in the same condition from poverty alone. The hair stands, the eyes water and have a dull fishy look, the nose also waters, occasionally the feet swell, also the jaw and sometimes under the belly, and the skin has a wrinkled appearance about the hind quarters. If inspanned they soon knock up and lie down in the yoke, and even if, as seldom happens, an ox recovers, he is never good for anything for at least three years, and then cannot do much work in a hot sun" (p. 53).

"Many traders have told me they believe one fly is sufficient to kill an ox, and natives say that if an animal is bitten slightly at one time, it is not a preventative against death if bitten at a future period" (p. 55).

[Some of the foregoing statements are reproduced in the paper by the same author entitled "Notes on the Chobe River, South Central Africa": *Proc. Roy. Geogr. Soc.*, Vol. III., April, 1881, p. 212.]

78. 1882. **E. C. Hore.**

"Lake Tanganyika" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. IV., pp. 1–2, 14–15).

Transport by bullock wagons, tried for the first time in Central Africa in connection with the London Missionary Society's pioneer expedition in 1877, *a failure owing to the Tsetse-fly.*

"*Road to the Lake.*—The road we were to take, though parallel to some extent with what might be called the old road used by Cameron and Stanley, was in fact almost entirely new. The portions from Saadani to Mpwapwa, avoiding the Makata swamp, were taken on the recommendation of Mr. Roger Price,* who had made a pre-

* *Cf.* [54].

liminary journey so far; . . ." "More than this, we were to introduce a new (for Central Africa, at least) system of transport—bullock waggons. Landing at Saadani in June [1877], we at once commenced training bullocks for this service, and at the latter end of July we really started for the interior with our bullock train. Succeeding eventually in reaching Kirasa [in the Mukondokwa valley], the bullock transport came to an end by the death of these animals by the Tsetse-fly. Every other difficulty had been overcome for 150 miles of the most difficult part of the road, and only in respect of the fatal Tsetse can this experiment be called a failure" (pp. 1–2).

The Tsetse-fly on the shores of Lake Tanganyika.

"The Tsetse-fly abounds on the lake shores from Ujiji round the south end and so up the west coast as far as Ubwari" (p. 2).

[The author met Capt. Carter, of the elephant expedition,* at the station of the African International Association at Karema, on March 26, 1880 (p. 14).]

"I was impressed very favourably with the accounts, and with what I saw of the elephant work. The surviving animal was one which for many years in India had done no work, and Carter was about to leave Karema for the coast to receive some more elephants from India with which he was to start the work of catching and taming the African ones. Why this work has been abandoned I cannot tell. It has been proved that waggons can be got through, but we cannot use bullock waggons on account of the Tsetse. I think it has been proved that elephants can be got through, but that they would not answer because of the immense labour and the number of men required to load and unload them daily, and because of the great weight concentrated on four points on shaky ground. By using elephant waggons both difficulties would be done away with, and both successes usefully combined" (pp. 14–15).

79. 1882. L. K. Rankin.

"THE ELEPHANT EXPERIMENT IN AFRICA: A BRIEF ACCOUNT OF THE BELGIAN ELEPHANT EXPEDITION ON THE MARCH FROM DAR-ES-SALAAM TO MPWAPWA" (*Proceedings*

* *Cf.* [66, 79].

of the Royal Geographical Society and Monthly Record of Geography. New Monthly Series. Vol. IV., pp. 277, 278, 283, 285–286, 288–289).

(Four Indian elephants were purchased from the authorities at Bombay by the Belgians belonging to the African International Association. They were landed at Msesani Bay, whence they marched to Dar-es-Salaam, early in June, 1879. The expedition was commanded by Captain F. F. Carter, who was joined by Mr. Rankin at Zanzibar before starting. The Kingani River was crossed at Gungu (lat. 7° 2′ N., long. 38° 37′ E.) on July 14, 1879.)

The elephants severely attacked by Tsetse beyond the Kingani, near the Lungwa river at Charinzi; they did not contract the disease, although donkeys attacked at the same time did so.

"On July 17th [1879] we first saw the Tsetse-fly, in a belt of country infested by it, through which we had been marching since crossing the Kingani. We were now face to face with one of the three problems the expedition had specially to solve, viz., could the Indian elephant, being removed by long captivity and by its artificial treatment from the safeguards of the wild state, resist the attacks of Tsetse, or would he, along with the ox, the horse and the donkey, succumb to them? The problem was solved, and that in the hoped-for manner. The fly swarmed on the elephants till blood trickled down their flanks in a constant stream. For days they endured this; and yet they showed no prolonged signs of Tsetse poisoning—lassitude, melancholy, running at the eyes—either at the prescribed time, viz., eight days, or afterwards, though they seemed pained and distressed during the infliction. The donkeys, on the other hand, sickened more and more after this, and at Mpwapwa were in a dying condition" (p. 277).

"Our next camp was at Tumundu in the district Kikunguri, chief Aceda Murumu; it was on the line of the lower road to Bagamoyo. The temperature was 89½° F.; height of position between 800 and 900 feet.

* * * *

"For the first time we now began to see giant creepers. After passing some conical mountains we came to a tract

of forest where every tree was hung, festooned, smothered, shrouded, enlaced, draped with convolvulus; tree was linked to tree in the most extraordinary manner, and the ground was carpeted with the plants. We here saw Tsetse again" (p. 278).

Tsetse-fly at Rumuma.—"At Rumuma I again saw Tsetse-fly, an observation which M. Broyon's experience confirms, he having lost some oxen through the fly after bringing them safely all the way to Mpwapwa" (p. 283).

On arrival at Mpwapwa, Aug. 3, 1879, *the elephants did not appear to be suffering from Tsetse-fly disease after twenty-three days' exposure to the fly.*—"At Mpwapwa our first task was to draw up the 'Report' for the King of the Belgians, of which, unfortunately, I have no copy; but I remember it contained the words: 'The elephant experiment has now been proved a complete success.' An assertion which Carter justified on the three counts of (1) Their immunity against Tsetse after twenty-three days' exposure to that insect; (2) their maintenance during one month mostly upon the uncultivated food of the country, and therefore at little cost; (3) their ability to march over all styles of ground, soft, stony, sandy, boggy; to conquer all eccentricities of topography—hill and dale, river and jungle—while labouring under double their due weight of baggage, some 1,500 instead of 700 lbs.; and this in a style that no other beast of burden could hope to emulate. At this distance of time, and notwithstanding the subsequent death of three elephants and the discontinuance of the experiment, I see no reason to withdraw a word of Carter's claim to success" (pp. 285–286).

"I have not the shadow of a doubt that there is yet a great future in Africa for the elephant, especially when the stage of capturing and taming the native species has been reached" (p. 288).

"Our troubles came in a cluster at and after Mpwapwa.* There one of the donkeys died, on August 30th. On stepping forth from my tent one morning, I saw the

* [Two elephants died at Mpwapwa. In the opinion of Mr. Rankin their deaths were due, at least in part, to overloading, excessive work, and insufficient and unsuitable food: the result in no way vitiated the success of the experiment as regards the ability of the Indian elephant to withstand Tsetse-fly disease.]

poor beast just outside, his neck over the medicine-chest. In his dire need he had crawled from his own quarters all the way to my tent. I could do nothing for him; the Tsetse had done their work" (p. 289).

80. 1882. Dr. E. Pechuël-Loesche.

"Die Loango-Expedition." Dritte Abtheilung, Erste Hälfte (Leipzig: Paul Frohberg), p. 299.

Tsetse-fly (? species) collected near Tschintschōtscho (a town on the coast about 100 miles north of the mouth of the Congo).* But a small herd of cattle is kept at Landana (a short distance south of Tschintschōtscho) and a larger one at Boma (on the north bank of the Congo, near its mouth), and the animals roam about freely and thrive tolerably well, so that the fly cannot occur in those districts [or else the hæmatozoon of Tsetse-fly disease is absent.]†

Reference to the failure of the attempt on the part of the Expedition to introduce cattle as beasts of burden [Cp. 65A].

Dr. Pechuël-Loesche mentions the general absence of cattle throughout by far the greater part of Lower Guinea; only to the south of the Kuansa River do they become domestic animals in the hands of the natives.

81. 1883. F. L. James.

"The Wild Tribes of the Soudan. An account of Travel and Sport chiefly in the Basé Country, being Personal Experiences and Adventures during Three Winters spent in the Soudan" (London: John Murray), pp. 128–129.

A disease of camels called by the natives guffer, *said by some of them to be caused by the Tsetse-fly.* (The district referred to is that to the east of Kassala.)

"There is a disease, very common amongst them [*i.e.*, camels], which the natives call the *guffer*. We were never able to clearly make out what this disease was. Some of the Arabs declared it was catching; others that it was not; but all said that a number of the camels we had bought on the Atbara were suffering from it when they were bought. Whenever we had to complain of any of the camel-drivers having, through negligence, allowed

* Cp. [65, 65A.] † Cp. [99].

a camel to run down, the excuse was that it was suffering from this mysterious disease, the *guffer*. We were once asked to look at a camel said to be suffering from this complaint. It was certainly in miserably poor condition, and at the time appeared to have a fit or convulsion of some kind. It rolled on the ground, apparently in great agony, and was only induced to get up after much difficulty. Somehow or other it got through the day's march, but was never afterwards good for much. Some of the natives said this disease was caused by the bite of the Tsetse-fly during the rainy season" (p. 129).

82. 1883. Karl Kraepelin.

"Zur Anatomie und Physiologie des Rüssels von Musca" (*Zeitschrift für Wissenschaftliche Zoologie*, 39. Band, pp. 683–719, Tafeln xl. und xli.)

83. 1883. G. Schoch.

"Die Tsetse fliege Afrikas" (*Mittheilungen der Schweizerischen entomologischen Gesellschaft*, Band 6. Heft 10, October, 1883, pp. 685–686).

"It is usual to designate by the name Tsetse-fly two long-winged Muscidæ of similar appearance, one as large as our house-fly, the other somewhat larger, and less dreaded. Their larvæ are said to live in the dung of big game" (p. 685).

Reasons advanced (p. 686) for considering that the fly is not poisonous, but "at most the carrier of a bacterium-like poisonous matter."

"We conclude, therefore, that the fly is not the producer of the poison, but at most the carrier of a miasma which arises here and there, and further that, with more intimate knowledge of the active principle, the disease can be successfully opposed, and will gradually disappear" (p. 686).

84. 1883. ——

"Journal de Genève," December 3.

An article on the Tsetse-fly, with statements by a certain H. F. Gros, with a view to showing that the belief in the harmfulness of the Tsetse is mere prejudice. [*Apud* F. M. Van der Wulp, *Tijdschrift voor Entomologie*, 1885, p. cv. I have not seen this paper myself.]

85. 1883. ——

"The delta and lower course of the Sabi River, according to the survey of the late Captain T. L. Phipson-Wybrants" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series, Vol. V., p. 274).

Tsetse-fly met with by Captain Phipson-Wybrants to the north-west of Mapeia's Kraal, on the Sabi, and between it and Macoupi's, November, 1880.

86. 1883. F. C. Selous.

"Further Explorations in the Mashuna Country" [1882] (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series, Vol. V., pp. 269, 270).

Tsetse-fly on the Panyame and Umsengaisi Rivers, at about 16° *S. lat.*, 1882.—On p. 269 is a map entitled—"Routes between the Umfule and the Zambesi, by F. C. Selous." On this the interval between the Panyame and Umsengaisi Rivers, on the 16th parallel S. lat., is marked—"A vast plain, covered with mopani forests. Very dry and swarming with Tsetse along the rivers, where game is also abundant."

"Below the mountains [the range to the south of the above plain, running due west from the Umvukwe Mts.] the Tsetse-fly are in millions, and we are very much annoyed by their incessant bites" (p. 270).

87. 1884. G. Macloskie.

"Kraepelin's Proboscis of Musca" (*The American Naturalist*, Volume XVIII., pp. 1234–1244, Figs. 1–12).

An abstract of Kraepelin's paper, "Zur Anatomie und Physiologie des Rüssels von Musca" [Cp. 82].

The author writes:—"Kraepelin's paper gives the most complete account extant of the structure of an organ which has excited interest since the time of Aristotle. His investigations were chiefly on the proboscis of the Blow-fly (*M. vomitoria*), and exclusively on its adult anatomy. The embryology of these parts has not been attempted by Kraepelin, baffled Weismann, and remains yet to be worked out. The following is an abstract of Kraepelin's paper with pen-and-ink copies of the more important of his thirty-eight fine illustrations. I venture to add some criticisms in the form of foot-notes."

88. 1884. F. M. van der Wulp.

"Iets over de Tsetse Vlieg (Glossina)" (*Tijdschrift voor Entomologie*, Zeven en Twintigste Deel, Jaargang 1883–84, pp. 143–150).

Includes a short bibliography. See also *op. cit.*, pp. xci–xcii.

89. 1885. J. M. F. Bigot.

"Genre Glossina" (*Annales de la Société Entomologique de France*, 6e Série, Tome Cinquième, pp. 121–124).

Synoptic table of six supposed species, in French; also the original description of *Glossina ventricosa*.

90. 1885. J. Mik.

Wiener Entomologische Zeitung, IV. Jahrgang, pp. 60–61.

An abstract of G. Schoch's paper, "Die Tsetse Fliege Afrikas" [Cp. 83]. The writer draws attention to the fact that there are three additional species of *Glossina* in Africa, while a fifth species, *Gl. ventricosa*, Big., is said to come from Australia. [As has been shown in the systematic portion of the present work, this is certainly a mistake.]

91. 1885. F. M. van der Wulp.

Tijdschrift voor Entomologie, Acht en Twintigste Deel, Jaargang 1883–85, pp. ciii–cvi.

Report of remarks by Heer van der Wulp, with subsequent discussion, at a meeting of the Nederlandsche Entomologische Vereeniging, held Jan. 25, 1885.—Certain previously published papers are quoted with a view to showing that Tsetse bite is not the cause of the deaths of cattle commonly attributed to it, or that, at any rate, the Tsetse merely disseminates noxious influences. Van der Wulp's own opinion, which he says he shares with Baron Osten Sacken, the well-known Dipterist, is that, although the cause of the mortality in cattle in Africa is not altogether clear, it is not, or at least not exclusively, due to the bites of Tsetse-flies, which in all probability are not more poisonous than European blood-sucking gnats and flies. A subsequent speaker (Heer Veth) considered it not impossible that by means of the Tsetse, as by other blood-sucking insects, highly-poisonous contagious matters are conveyed into the blood.

92. 1885. **W. Marshall.**

"Ueber die Tsetse-Fliege" (*Biologisches Centralblatt*, V. Band, pp. 183–184).

A résumé of F. M. van der Wulp's remarks reported in the *Tijdschrift voor Entomologie*, Vol. 28, pp. ciii–cvi [*vide* 91].

93. 1885. **E. H. Richards.**

"An American Missionary's Journey in East Africa, West of Inhambane" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography*. New Monthly Series, Vol. VII., p. 381).

Mr. Richards made a journey from Inhambane to the Limpopo,* in October, 1884: *the Tsetse-fly was first met with in Makwakwa-land, to the west of the Makwakwa ridge.*

"The Ama-kwakwa tribe was encountered on the third day. . . . Many kraals were deserted, and a tract of country seventy-five miles wide by a greater distance in length lying west of the Makwakwa ridge was nearly desolate. It was in this semi-deserted region that the Tsetse-fly was first seen. The route lay to the W.N.W. along the northern border of Makwakwa-land."

94. 1885. **F. L. James.**

"A Journey through the Somali Country to the Webbe Shebeyli" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography*. New Monthly Series, Vol. VII., p. 633).

Fly (? Tsetse) on the Webbe Shebeyli in the wet season.—"Like the Somal, the Adone [the people on the Shebeyli] have large herds of cattle and flocks of sheep, but all these animals are poor and suffer from the fly in the rain and from the ticks in the dry season; neither camels nor horses are used, for they will only live in the dry season; but the Rer Hamer, who leave the river valley for the plateau in the wet season, bring numbers to graze there in the winter."

95. 1885. **H. M. Stanley.**

"The Congo and the Founding of its Free State: A Story of Work and Exploration" (London: Sampson Low, Marston, Searle and Rivington), Vol. I., p. 419.

* [On a subsequent page (459) the river reached is stated to have been the Luizi, and not the Limpopo.]

Author bitten by Tsetse (and horse-flies) on board a river steamer at Kemeh I., in the Kwa R., an affluent of the Congo, above Stanley Pool, May 21, 1882. (Approximate position of Kemeh I., from author's map, 2° 45′ S. lat., 17° 2′ E. long.)

96. 1886. H. Capello and R. Ivens.

"De Angola á Contra-Costa," Vol. II. (Lisboa: Imprensa Nacional), Capitulo XVIII., "A Tzé-Tzé," pp. 21–39.

A chapter on the Tsetse (in Portuguese): rough woodcuts of head and foot enlarged, on p. 23.

97. 1886. W. M. Kerr.

"A Journey from Cape Town overland to Lake Nyassa" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography*. New Monthly Series. Vol. VIII., p. 74, Map, p. 136).

Tsetse-fly near Chibinga, Mashonaland, July, 1884.—"The Tsetse-fly abounds in these parts, consequently cattle and horses are unknown. Poultry of small size seem to do well. The native women dry quantities of the Tsetse-fly and pulverise it with the bark of a root, and mixing it with water give it to the young animals, such as dogs and goats or sheep, of which they have very few, seemingly only kept as pets."

98. 1886. W. M. Kerr.

"The Far Interior: A Narrative of Travel and Adventure from the Cape of Good Hope across the Zambesi to the Lake Regions of Central Africa" (London: Sampson Low, Marston, Searle and Rivington), Vol. I., pp. 282, 293, 306, 307; Vol. II., pp. 24, 33, 48, 54, 63, 65, 75, 118, 193.

1884.—*Tsetse-fly at Suru*, to the north of the Makomwe Mts., on the north bank of the Msingua River, a tributary of the Umkumbura, which is an affluent of the Zambesi (Vol. I., p. 282). Approximate geographical position of Suru, from the author's map, 16° 20′ S., 31° 55′ E.

Tsetse-fly at and near Chibinga, on the north bank of the Msingua, about 10 miles north-west of Suru (1884).—"Flies were literally in myriads. Fortunately the

Tsetse-fly—although swarming in the neighbourhood, and, in fact, throughout all this belt of country between the foot-hills of the Makomwe mountains and the Zambesi—did not trouble us. In the town it was by no means constant in its attendance; in one place they might be innumerable, but a mile further east, few could be seen" (Vol. I., p. 293).

Tsetse-fly on the Mukumbra (Umkumbura) River (called *Ukumbura* on author's map): 1884.—"Soon we arrived at the Mukumbra River, which may be described as a long winding stretch of sand. It forms a very wide road (broadening in some places to three, four, or six hundred yards) through the vast forest, its shifting sands extending to the union with the Umzengaizi River about 12 miles south of the Zambesi. . . . Upon these low and dry sands we saw the spoor of almost every description of wild animal. . . . It was now late and we had had a very hard day; the first on which I had got a real 'benefit' from the Tsetse-fly. The condition of torment which I thought tiresome before, I would now have welcomed as a state of comparative bliss. The heat had been intense. Bathed in perspiration we walked through the shifting sand, which yielded like soft snow under the feet, while the stifling sultry air was literally alive with the Tsetse-fly, against whose maddening attacks clothes were no protection, our only safeguard being to beat them off with twigs and small branches of shrubs, giving a by no means pleasant exercise under a torrid heat. For the same purpose the natives generally use the tail of a buffalo mounted on a wooden handle, an implement with which they swish their naked bodies while travelling through the fly-infested country. . . . Fortunately at night the flies take a rest; but I have felt them 'stick' more than once during nocturnal hours. General experience, however, shows that they do not give much trouble after sundown" (Vol. I., pp. 305–307).

Tsetse-fly between Chibinga and Tette: 1884.—"Tsetse-fly varied in numbers. Sometimes they were swarming, at other times few were to be seen" (Vol. II., p. 24).

Tsetse-fly and goats in the Zambesi valley, to the west of Tette: 1884.—"The Tsetse abounds throughout the widespread valley. It has been remarked that the goat

will live in the 'fly country.' But to me it was singular that wherever goats were found in any considerable numbers the fly was not observed. Where the fly was prevalent, goats were sometimes kept as pets which had been born in the 'fly country' (their mothers having died), and physicked, when very young, by the women" (Vol. II., p. 33).

Tsetse-fly not seen by the author in the centre of the town of Tette: 1884.—"In the heart of the town I never saw the Tsetse-fly. Therefore a few poor-looking cows were kept, but were not allowed to wander far. With reference to the Tsetse, I should mention that when game, such as the buffalo, elephant, etc., become scarce, as was the case recently in the neighbourhood of Delagoa Bay, the fly in a great measure disappears, it being said, with good authority, that the little pest breeds upon the buffalo-dung. Doubtless when the game, at present plentiful, disappears from the Zambesi valley, a like result will follow" (Vol. II., p. 48).

Tsetse-fly on the Zambesi, at Tette: 1884.—"Tsetse-fly abounds on the southern side, and there is also a belt of it on the northern lands contiguous to the river" (Vol. II., p. 54).

Tsetse-fly on the Revuqwe River, about six miles above its confluence with the Zambesi: 1884.—"A sharp prick at this time made me renew my acquaintance with the Tsetse; after sundown, too, which was rather alarming" (Vol. II., p. 63).

Tsetse-fly swarming in places during a few days' march in a north-easterly direction from the above locality on the Revuqwe: 1884.—"Forests of varying density were penetrated in our route during the next few days. Mopani, thorn jungle, long coarse grasses, and clusters of bamboo were the principal growths. River-beds of dry sand, such as the Matizi, Nyamtara, and Nyabzigo, ran through the country.

"The Tsetse swarmed in certain localities, but altogether they were not so bad as we had found them here and there farther south" (Vol. II., p. 63).

Tsetse-fly between the Shikambe River and the south-western extremity of the Salumbidwa Mountains: 1884.—Approximate geographical position, from the author's map,

15° 56′ S., 33° 55′ E.—"Pursuing our course for two days through an uninteresting country, covered with tropical vegetation, we crossed the Shikambe and Mbjova rivers, both of which give their waters to the Zambesi above Lupata gorge, and pitched a camp at a place which I have designated the Palm Wells, 800 feet above the sea. . . . Every now and then the Tsetse would alight upon our thinly-clad bodies, making us jump again as though twitched with the fine lash of a whip" (Vol. II., pp. 64–65).

Tsetse-fly near the southern base of the Kapirizange Mountains: 1884. Approximate geographical position, from the author's map, 15° 49′ S., 34° 5′ E.—"Just before beginning the ascent of the Kapirizange range, I had seen Tsetse-fly; but in the mountains none were to be found" (Vol. II., p. 75).

Donkeys, though "more tenacious of life than horses or oxen when in the fly country," eventually "pine away and die like other victims" (Vol. II., pp. 118–119).

Tsetse-fly not seen in the vicinity of Livingstonia, at the southern end of Lake Nyasa: 1884.—"No Tsetse-fly was seen here, but it is more than probable that the deadly insect is as migratory in its habits as the game on whose dung it breeds"* (Vol. II., p. 193).

[In the map at the end of Vol. II.—"Map showing route from the Cape of Good Hope across the Zambesi River at Tette to Lake Nyassa in 1884. From the Survey by W. Montagu Kerr, C.E. *Scale of English miles*—1 inch = 38 miles"—the occurrence of the Tsetse-fly in different regions is shown in red. A dotted curved line running from about 19° 10′ S. lat., and the 29th parallel East longitude to about 17° 50′ S., 30° 35′ E., is marked "Approximate Southern Limit of Tsetse-Fly." The "Southern Limit of Tsetse-Fly," south of the Zambesi, is again shown by a line running east and west from about 16° 20′ S., 31° 8′ E. to 16° 20′ S., 32° 20′ E.; the country between this line and the Zambesi is marked "Tsetse-Fly Belt." North of the Zambesi a line running W.N.W.—E.S.E., across the northern extremity of the Salumbidwa Mountains, from about 15° 45′ S., 33° 40′ E.,

* [Captain J. F. Elton found Tsetse abundant at Livingstonia in August 1877.—*Cf.* 59.]

to about 15° 53′ S., 34° 30′ E., is indicated as the "Northern Limit of Tsetse-Fly." Besides the above, "Tsetse-fly" is shown as occurring to the N.E. of Tette, S.W. of the intersection of the 16th parallel S. lat., and 34th meridian E. long., and also at the southern end of Lake Nyasa, on the western side of the southern extremity of the bay to the west of the promontory on which Livingstonia is situated. Two localities bear the words "No Tsetse-Fly"; the first a valley among the foot-hills to the east of the Umvukwe Mountains, in the Makorikori country: approximate geographical position, 16° 55′ S., 31° 40′ E.; the second a portion of the valley of the Vilange River, an affluent of the Revuqwe, approximate geographical position, 14° 57′ S., 34° 14′ E.]

99. 1887. **Josef Chavanne.**

"Reisen und Forschungen im alten und neuen Kongostaate in den Jahren 1884 und 1885" (Jena: Hermann Costenoble), p. 365.

The fact that cattle thrive fairly well, in spite of an only moderate supply of unsatisfactory fodder, shows that the region of the Lower Congo is free from Tsetse-fly.*

100. 1887. **Hermann Habenicht.**

Justus Perthes' Spezialkarte von Afrika, *entworfen von Hermann Habenicht* (Gotha, April, 1887). Scale 1 : 4,000,000.

Sections 9 ("Capland") and 10 ("Delagoa Bai") show by means of dotted lines the limits of the Tsetse-fly north and south of the Limpopo, and south of the Zambesi.

101. 1887. **Dr. C. W. Schmidt.**

Berliner Entomologische Zeitschrift, XXXI. Band, p. 368.

Tsetse-fly stated not to occur in Usambara and Bondei [districts near the Pangani River, German East Africa]. Cattle can therefore be kept on a large scale in Usambara.†

102. 1888. **A. Laboulbène.**

Annales de la Société Entomologique de France, 6e Série, Tome Huitième, Bulletin, pp. lxxxviii, clviii.

* [*Cf.* 80.]

† *Cf.*, however, Dr. Stuhlmann's statements [XXVI.].

Opinion expressed that the Tsetse is not poisonous in itself. The ravages of the Tsetse or of the species of *Glossina* appear to the author to be due to septic matter derived by the insect from unhealthy animals or from carcases, and inoculated from one animal to the other (p. lxxxviii).

A communication read from R. P. Leroy, according to which the Tsetse is very troublesome in the dry and sterile plain between Ukami and Nguru (inland from Bagamoyo), on which buffaloes, zebras, giraffes, and antelopes abound, while there are even a few elephants. Leroy states that a Masai army with a herd of 300 cattle, camped on the plain in order to attack Mrogoro, was forced to beat a precipitate retreat in consequence of their cattle having been put to flight by the Tsetse. Laboulbène explains that he did not attribute the effects of the bite of the Tsetse to the fly having previously settled on putrefying carcases. He adds: "I think that it carries with its proboscis septic matter drawn from diseased animals, and communicates it to others that are healthy, the result of which is illness and possible death. It remains to be explained why the bite, which is said to be deadly to cattle, is not so to human beings" (p. clviii).

103. 1888. **A. Laboulbène.**

"Une Mouche Tsé-Tsé de l'Afrique tropicale" (*Revue Scientifique*, Troisième Série, Tome XV, p. 700).

Contains no fresh facts: according to a foot-note, the article is an extract from a communication made by the author to the Académie de Médecine, at a meeting held May 29, 1888. [The title of this communication is, "Sur une mouche tsé-tsé de l'Afrique Australe": Bulletin de l'Académie de Médecine, Paris, 1888, 2e Série, XIX, pp. 721–724.]

104. 1888. ——

"Dr. Holub's Journey in the Batoka Country" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography*. New Monthly Series. Vol. X., p. 647.)

Tsetse-fly in the Batoka country, 1886.

"He [Dr. Holub] says the country of the Batoka is

wooded, but the forests are only composed of small trees, in which the Tsetse-fly abounds."

105. 1888. F. Jeppe.

"The Kaap Gold-fields of the Transvaal" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. X., p. 441).

Partial disappearance of the Tsetse-fly together with game from the Kaap Valley.—"Game has almost disappeared, frightened by the reports of the dynamite and the prospector's gun, and the Tsetse-fly has gone away with the game, save in some parts of the valley. The valley, formerly teeming with all kinds of game, from the elephant to the steinbuck, is now deserted except by a stray leopard in the kloofs, or the lion on the Lebombo flats, where more game is found."

105A. 1888. Prof. A. H. Keane.

Article "Transvaal" in *Encyclopædia Britannica,* 9th edition, Vol. XXIII., p. 518.

"A tsetse belt 40 miles wide along the whole course of the Limpopo still bars the spread of European settlements beyond Transvaal in the direction of the Zambesi."

106. 1888. ——

"Tsetse-fly (*Glossina morsitans*)" (*Encyclopædia Britannica,* 9th edition, Vol. XXIII., p. 601).

A short article.—"At present no cure is known for the bite, nor does inoculation seem to afford any protection. The fly is said to avoid animal excreta, and in some parts a paste composed of milk and manure is smeared on cattle which are about to pass through the 'fly-belts.' This affords a certain amount of protection. Lion's fat is used in the same way, and is said to be efficacious.

"The fly is found as a rule in the neighbourhood of water, and its habitat is usually sharply defined. Often it occurs on one side of a stream, but not on the other. The limits of the 'fly-belts' are well known to the natives, and travellers can ensure comparative safety to their cattle by passing through these districts after sundown. The northern limits of the area inhabited by

the Tsetse are not known. It is found throughout the valley of the Limpopo River, but does not come much south of this, except in the eastern borders of the Transvaal. Here it extends far south of Delagoa Bay, and infests the Lobombo Mountains and the Amatonga country, reaching to the confines of Santa Lucia Bay. It appears to be gradually retreating northwards following the big game."

107. 1889. **Dr. Preuss.**

"Bericht von Dr. Preuss über botanische und entomologische Beobachtungen auf der Barombi-station" (*Mittheilungen von Forschungsreisenden und Gelehrten aus den Deutschen Schutzgebieten.* Mit Benutzung amtlicher Quellen herausgegeben von Dr. Freiherr von Danckelman (Berlin: Kommissions-Verlag von A. Asher & Co.), II. Band, 2. Heft, p. 60).

A species of Glossina *at Barombi Station, Cameroons.*

[Translation.] "On the other hand, a yellowish-brown *Glossina* is distinguished by its particularly painful bite (*Stich*). This fly is found chiefly in the primeval forest, and pursues and persecutes human beings with downright revolting cunning and pertinacity. When one is bitten a small drop of blood at once exudes and the place becomes much swollen."

[Barombi Station is situated to the south-east of Barombi, or Elephant Lake, a little to the south of 5° N. lat., and just E. of 9° 30′ E. long.]

108. 1889. **F. S. Arnot.**

"Journey from Natal to Bihé and Benguella, and thence across the Central Plateau of Africa to the Sources of the Zambesi and Congo" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. XI.

Tsetse-fly prevalent "in the country between the Mababi flat and the Zambesi" [1882] (p. 67).

109. 1890. **John B. Smith.**

"Notes on the Structure and History of Hæmatobia Serrata" [= *Lyperosia* (*Hæmatobia*) *irritans, L.*]: *Psyche*, Vol. V., pp. 343–347, figs. 1 to 6 (woodcuts of details of proboscis and other organs).

110. 1890. Dr. E. Holub.

"Von der Capstadt ins Land der Maschukulumbe." Reisen im südlichen Afrika in den Jahren 1883–1887. (Wien: Alfred Hölder), II. Band, pp. 10–12, 191, 398, 483, *et seq.*

From Panda-ma-Tenka to Gazungula, June, 1886.

[Translation.] "In the night between June 1st and 2nd we set out in order by the aid of the waggon to transport the greater part of my belongings to the mouth of the Chobe—*i.e.*, to the southern bank of the Zambesi, which, on account of a shady Gazungula tree which stands directly on the shore, is called Gazungula—there to remain until we crossed the Zambesi. . . . We found ourselves obliged, as already mentioned, to cover the intervening space by night, since on part of the road to be traversed the Tsetse-fly was still to be found during the heat of the day, so that this spot could only be passed at night. If, as it has hitherto been customary to believe, the Tsetse-fly is really the destructive agent that kills our domestic animals in certain districts of Africa by means of its poisonous bite, it is, in my opinion, no protection to pass certain thickly wooded laterite knolls, which usually cross our path at right angles and are infested by Tsetse, in the night, that is at a time when this dangerous insect is resting on twigs asleep. The path is so narrow and the trees are so close to it, that it is quite impossible to pass without the trek-oxen and the waggon scraping against the twigs and so shaking off the Tsetse and carrying them along with them. I found that at the time of my first visit, on the section from Panda-ma-Tenka to the mouth of the Chobe, the Tsetse-fly extended from Schneemann's Pan (12 English miles from Leschumo Station) to the Chobe mouth. Since then, in consequence of periodical forest fires, the Tsetse-fly in this district has gradually been destroyed, until it has been restricted to one laterite knoll close to the spot where the Leschumo Valley opens into that of the Zambesi.

"As, however, a waggon passed this spot at the most twice or three times a year, no opportunity was afforded for transporting the poisonous fly to any considerable extent, and it remained confined to the narrow

tract of woodland already referred to. But when, in the year 1885, the missionary Coillard repeatedly drove from the Leschumo to the Zambesi in order to migrate to Sesheke, and when besides in the year 1886 the trading-store was transferred from Panda-ma-Tenka to Gazungula, and the spot was thus frequently passed with waggons and draught animals, it was naturally quite possible for the fly to be transported to the Leschumo Valley. I already expressed this apprehension on this my first visit to the Leschumo Valley (February, 1886), and was glad when I was at last able to take my departure and had brought my trek-oxen safely out of the Leschumo Valley to Panda-ma-Tenka again. It was indeed high time that this should be done, for when, after I had accomplished my journey, Messrs. Westbeach and Coillard travelled more frequently to and fro between the Leschumo Valley and the Zambesi, so many of the flies were transported to the former valley, that the insect was able to establish itself there, and moreover the consequences of this soon showed themselves. The draught animals belonging to other travellers, who came from the south into the Leschumo Valley, fell sick with the symptoms of Tsetse poison, and perished all but two. This much is certain, that this dangerous insect, which will cause great difficulties in the colonisation of South Africa, recedes and disappears before the advance of civilisation.

"The Leschumo Valley from the mission station occupied by us as far as its opening into the Zambesi Valley exhibits a slightly mountainous character; it is only a few hundred metres in width, covered with high grass and wooded like a park, and is bordered on each side by the high laterite ridge. Now at the mouth of the Leschumo Valley the laterite ridge on the left sends a spur towards that on the right, and this wooded spur is said to have constituted the fly-belt that still remained here, while the level, meadow-like, bushy and wooded tract extending from the spurs as far as the Chobe and Zambesi Rivers is said to be free from Tsetse. The latter I have never believed, and I think that those also who maintained it did not believe it to start with, for otherwise, why did Messrs. Westbeach and Coillard, as often

as they had brought their goods to Gazungula by night, drive their teams the same night back to the Leschumo Valley? This precaution on their part seemed, however, gradually to be neglected; and, in spite of my remonstrance, Coillard left his teams in Gazungula, since Mr. Westbeach's remark that there was 'no Tsetse-fly in Gazungula' carried more weight than my advice" (p. 10–12).

Tsetse-fly along the Mo-Njeko River, and in the elevated plain to the north of Masosa Village, on the southern confines of Mashukulumbe Land. The Matoka in this district possess cattle, sheep, goats and dogs, but they are dwarfed, and the author thinks that this is due to the effects of fly-bite.—Approximate geographical position of Masosa, according to the author's map, 16° 12′ S., 28° 7′ E.

"On this day [July 16, 1886] we had emerged from the northern Matoka Highlands, and now stood on a plain, which once more towards the north appeared to descend to the Luenge, and was bounded only towards the east and in the distance by a tract of highland, and in the west by the elevation of laterite rock. This plain, which extended in front of us far towards the east, north-east and north, is stated by the Matoka to be a region free from Tsetse-fly. Here were situated a few cattle-posts belonging to King Mo-Panza and certain of his chiefs, who prided themselves not a little upon their small stock of cattle. . . . The news about the Tsetse-fly seemed to me to be absolutely incredible, for I satisfied myself that down below on the river, but especially on the further bank, even then, though it was winter, the Tsetse-fly occurred in much greater numbers than at any of the other places north of the Zambesi, though, unfortunately, we had found these localities everywhere infested by this destructive insect. The Tsetse also existed on this plain, and I think that the cattle that occur there have indeed accommodated themselves to the poison of this fly, but have remained so diminutive [the northern, or Maschukulumbe race of the cattle belonging to the Matoka, 'small cows and oxen not above middle size'] owing to the influence of the poisonous insect, that is, they have degenerated, just as the Matoka in the Tsetse country are able to keep only stunted sheep, goats and dogs" (p. 191).

Abundance of Tsetse on the Mo-Njeko, near Masosa Village, August 7th, 1886.—"I had started about half-past five in the morning, and it must have been about two o'clock when I reached the Mo-Njeko, and soon afterwards the little village on the south (right) bank. Nowhere had I yet beheld so many Tsetse-flies as here. On sitting down by the margin of the Mo-Njeko river—the current was only very slight—and bathing my feet in the clear water, I scarcely had time to keep the Tsetse-flies off poor Daisy, who this time had accompanied me. That Daisy did not succumb to the bites of the Tsetse is doubtless due to the fact that previously on the Limpopo he had thrice eaten meat poisoned with strychnine" (p. 398).

Gazungula to Shoshong, 29th November, 1886, *to 11th February,* 1887.—Sickening and subsequent death of 27 oxen from Tsetse-fly disease; serious illness of remainder (pp. 483, *et seq.*).

111. 1891. **Major Gaetano Casati.**

"Ten Years in Equatoria" (London and New York: Frederick Warne & Co.), Vol. I., p. 234.

Tsetse-fly in the Mambettu Country, west of Lake Albert Nyanza, south of the Niam Niam Country, and north of the Nowelle or Aruwimi River.

"Cattle cannot be successfully reared by the Mambettu on account of a fly called *Tsetse,* the stings of which cause death. . . ." (p. 234). Reduced copies of Westwood's figures of fly and mouth parts.

112. 1891. **E. A. Maund.**

"On Matabele and Mashona Lands" (*Proceedings of the Royal Geographical Society and Monthly Record of Geography.* New Monthly Series. Vol. XIII.).

"Three scourges farmers have to combat: lung-sickness among cattle, horse-sickness, and the Tsetse-fly. . . . The Tsetse-fly, whose bite is so deadly to domestic cattle, will disappear with the game. The Transvaal, since the game has been so shot out, is now nearly free from this pest. The Mashonas dry and pound the fly, and give it to their dogs, a fly a day, as a safeguard against the effects of it" (pp. 11–12).

113. 1891. J. M. F. Bigot.

Annales de la Société Entomologique de France, Année 1891, Vol. LX., pp. 377–378.

Original descriptions of *Glossina grossa* and *Gl. pallicera*.

114. 1892. J. A. Nicolls and W. Eglington.

"The Sportsman in South Africa" (London: The British and Colonial Publications Company, and Simpkin, Marshall, Hamilton, Kent & Company, Limited), pp. 17, 73.

"Some Remarks on the Shooting Horse and the Hunting of Large Game.—If we except those portions of the low-lying and most unhealthy country on the East Coast between the mouths of the Zambesi and Crocodile Rivers which are impenetrable to horses on account of the presence of the Tsetse-fly pest, all the ordinary larger game (if the Koodoo and different varieties of water-loving antelopes be excluded) nowadays roam so far from the permanent waters as to render hunting on foot almost a sport of the past" (p. 17).

"In South-Central Africa, or, indeed, wherever the Buffalo is met with in abundance, the Tsetse-fly (*Glossina morsitans*) is everywhere prevalent." Symptoms of fly-bite in horses and oxen. "Some authorities are willing to account for this pest being always found in attendance on the Buffalo by the fact that the insect hatches its eggs in the skin or the dung of that animal" (p. 73).

115. 1893. Captain F. D. Lugard, D.S.O. (now Sir F. D. Lugard, K.C.M.G., C.B.).

"The Rise of Our East African Empire" (Edinburgh and London: William Blackwood & Sons), Vol. I., pp. 389–390, 390–391.

"On the other hand, East Africa has many great advantages. It is practically free from the Tsetse-fly (*Glossina morsitans*) which arrests progress in South Africa" (pp. 389–390).

"South Africa, as I have said, is at a disadvantage by reason of the Tsetse-fly, which precludes all forms of animal transport, and all agricultural methods which depend on the use of the horse, bullock, or donkey, as well as all stock-rearing farms. Hides, ghi, milk, and beef are products which cannot be procured in the

infested districts. In German East Africa throughout the broad zone, which he describes as the coast area, Dr. Pruen says 'the Tsetse-fly holds undisputed sway.' In British East Africa the fly has been found in an extremely narrow strip of country near Taita, but so far it has only been caught as a natural history curiosity. Indeed, by diverging either to the right or the left, it can, I think, be avoided, for it is doubtful if it exists on the Sabakhi River, and Mr. Jackson * says that, proceeding from Mombasa *viâ* Taveta to Machako's, 'Throughout the whole of the way both good water and fodder are plentiful; there is no thick bush, and there are no Tsetse.' Mr. Jackson is a competent authority, who has travelled in this district (Taveta), and it was by him that the Tsetse-fly in the direct route was first discovered and sent home for identification to the British Museum. Thus transport animals could be used throughout East Africa from the coast to the far interior. Even across the strip of country in which it has been found the Arabs and Swahilis have for years driven trains of pack bullocks and donkeys in their slow-moving caravans, and from this it would appear that the fly can hardly be said to exist in sufficient quantities to be a real obstacle, for these people could not afford to risk the loss of even a few animals. The Company have sent up caravans of donkeys, but I greatly doubt if the mortality amongst them was due to Tsetse. Three horses were safely imported to Uganda; and the tribes breed and rear cattle continuously from the coast to the far interior" (pp. 390–391).

116. 1893. **Theodore Bent.**

The Standard, October 11, 1893.—Interview with a representative of Reuter's Agency.

Importance of the Beira Railway, in that by its aid it is possible to cross the Tsetse belt without difficulty. Numbers of waggons seen rotting on the roadside near Chimioyo, "all the oxen having succumbed to the attacks of the fly."

117. 1893. **V. von Röder.**

Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten, X. Band, p. 205.

* *Pall Mall Gazette*, Feb. 4th, 1893 [*Cf.* 119].

Glossina morsitans, Westw., taken at Mbuzini, in Uzeguha, German East Africa, 27. viii. 1888, by Dr. Fr. Stuhlmann.

118. 1893. **Major J. J. Leverson.**

"Geographical Results of the Anglo-Portuguese Delimitation Commission in South-East Africa" (*The Geographical Journal*, Vol. II. London: The Royal Geographical Society).

Tsetse-fly on and near the Pungwe River, 1892.

"When proceeding up-country from the Pungwe we did not get clear of the Tsetse-fly till we reached Shimoya's. Thence to Massi-Kessi ox-waggons brought down from Mashonaland were able to work along the road. South of Massi-Kessi, the only place in which we came across the fly was in the neighbourhood of the Sabi. Five ponies which we took with us from Natal all died, or had to be shot within six weeks of their landing at Beira. We also lost from fly-bite every one of twelve oxen which made the journey from Shimoya's to Mandigo's and back, a section of the Beira Massi-Kessi road which till the commencement of 1892 was believed to be free from fly" (pp. 517–518).

119. 1893. **F. J. Jackson.**

Pall Mall Budget, February 23, 1893, p. 295.

Notes, in an interview entitled "Uganda Once More," on the *Tsetse-fly on the Teita-Kibwezi route to Uganda, in* 1892–93.

"Nearly the whole way is bush between Teita and Kibwezi, in which there is very little fodder to be found, and that of a coarse and very inferior kind. Further, as you approach the Tsavo, after leaving Teita, you have to pass through the Tsetse-fly country, and that continues until you reach Kibwezi. The Tsetse is a small fly, rather larger than the common house-fly, of a brown colour, with a yellowish line down the centre of the body. This fly attacks men and beasts both by day and night. It can easily bite through khaki breeches or flannel pyjamas. Where it exists—and it is extremely local—it appears in much greater numbers on a dull or rainy day. Its bite in man, though very sharp and needle-like, leaves no irritation, and it invariably chooses those parts that are shaded

from the rays of the sun—such as under the brim of the hat, behind the ear, neck, and under the throat if not protected by a beard. If allowed to suck itself full, its body becomes so distended that it has the appearance of a small unripe purple grape, and it is unable to fly more than a few yards before settling. Its proboscis, which is very slightly curved downwards, is attached to the head horizontally, and is protected by a sheath divided longitudinally. When it bites, the proboscis is vertically lowered, whilst the double sheath is retained in its horizontal position. This fly is perfectly harmless to human beings, but its effect on domestic animals is of the most disastrous nature—in fact, as far as my knowledge goes, all domestic animals, with the exception of goats, and perhaps of the grey donkey, when struck by this fly are bound, sooner or later, to die. I do not believe that donkeys are impervious to its bite, and I think that the wasting disease which kills off so many of them comes from the effect of being bitten by these flies. I have seen a bullock cut up, after dying from these wasting symptoms, which I knew to have been bitten by the Tsetse; the whole of the juices of the body were turned into greenish-yellow slime. I sent home a number of these Tsetse which I caught myself, and which were certified as the genuine fly by the authorities at the British Museum. . . . The route which appears to me to be far more practicable for transport by means of animals is that by Taveta, which lies at the foot of Mount Kilima-Njaro, and from there runs almost direct northwards to Machakos. Throughout the whole of that way both good fodder and water are plentiful; there is no thick bush, and there are no Tsetse. The fact of the immense herds of native cattle which the Masai have roaming over all these plains is sufficient to prove this; if these herds are able to live, the Tsetse cannot be there. . . . The depôt at Taveta would have to be built outside the forest, on the banks of the River Lumi, as there is a fly, not the Tsetse, but exactly like a house-fly with a long proboscis, that is very plentiful inside, and worries beasts to such an extent that they are unable to eat, and die."

[The fly alluded to in this last paragraph is obviously a species of *Stomoxys*, and since *Trypanosoma brucei* was

found by the late Captain Haslam in specimens of *Stomoxys* on the line of the Uganda Railway, it is quite possible that the animals that Mr. Jackson considers to have been *worried* to death by *Stomoxys* at Taveta really perished from Nagana. In this connection it is worthy of note that Dr. J. W. Gregory attributed the death of his camels at Ngatana to the bites of a *Stomoxys*.

The above article is illustrated by a small sketch-map of alternative routes from the coast to Uganda, showing "Tsetse-fly country" near Kibwezi, and also by a rough wood-cut (three times natural size) of a Tsetse-fly.]

120. 1893. Captain Foster.

"HANDBOOK OF BRITISH EAST AFRICA" (prepared in the Intelligence Division, War Office, 1893), pp. 93, 111.

Tsetse-fly during the wet season infests some 60 miles of road up country near the Tsavo; it is believed that donkeys withstand the attacks of the fly better than other animals (p. 93).

Tsetse-fly common on the Sabaki River route (which follows the river) between Mombasa and Tsavo; on the Taru desert route the fly does not appear till the valley of the Tsavo is reached (p. 111).

121. 1893. F. C. Selous.

"TRAVEL AND ADVENTURE IN SOUTH-EAST AFRICA" (London: Rowland Ward & Co.), pp. 54, 55, 63, 99, 202–203, 208, 215, 245, 246, 250, 274, 410–411, 426.

Tsetse-fly said to be on the Savakaranga, a small stream between the Manyame and Umsengesi Rivers, tributaries of the Zambesi, in northern Mashonaland (p. 54).

Tsetse-fly making its presence disagreeably felt in the Zambesi Valley, between the Manyame and Umsengesi Rivers (p. 54).

"The Tse-tse-fly swarmed along the River Kadzi [near the Umsengesi], and was a great pest, keeping one in a perpetual state of irritation all day long" (p. 55).

"The Tse-tse-fly swarms on both sides of the river in the immediate vicinity of Zumbo [a town on the northern shore of the Zambesi, close to the confluence of the River Loangwa], so that cattle cannot be kept there. . . ." (p. 63).

Tsetse-fly on the Sabi River, Matabeleland.—"I was

now close to the edge of the 'fly' country, which at this time [1883] extended from here [on the Upper Sabi, where the river crosses 32° E. long.] southwards along both banks of the Sabi" (p. 99).

Resisting power of the donkey to Tsetse poison.—"In countries where the Tse-tse-fly is in excessive numbers, the donkey, strong as he is, will not live long; but he resists the poison far better than any other domestic animal, and will pass through belts of 'fly' country without taking much harm, his constitution being so strong that he will recover from the effects of the poison if not kept too long in the infected district, whereas an ox or a horse, if once impregnated, will almost to a certainty pine away and die. I say almost to a certainty, because I have heard of cases of oxen and horses recovering after having been bitten; but such cases are very exceptional. The younger the animal, whether horse, ox, or donkey, the better will he resist the 'fly' poison" (pp. 202–203).

Tsetse-fly numerous between the Zongwe River and Zambesi, in the Batonga country to the north of the latter river.—"Tse-tse-fly were also pretty numerous, and must be very much so later on during the hot months" (p. 208).

Tsetse-fly on the Loanja River, "or rather swamp," which joins the Zambesi north of the confluence of the Chobe.—"The road from here follows the western bank of the Loanja for about forty miles, the whole of which distance is infested with 'fly,' and has therefore to be traversed at night by both oxen and horses. It can be done in two nights by ox-waggons, but is usually done in three, and there are two islands in the swamp free from 'fly,' to which the oxen can be driven to feed and rest during the daytime. These islands are, too, conveniently situated so as to divide the journey into three easy nights' work" (p. 250).

Cattle at Tete, on the Zambesi, "originally brought from Mashonaland; though how they passed the 'fly' infested district between Tete and that country is a mystery to me" (p. 274).

Tsetse-fly in 1891 *on the west bank of the Revui River*, a tributary of the Buzi, which flows into the sea just below the Pungwi, a little south of Beira; the flies settled on two horses in a little clearing on a hippopotamus footpath "leading through the dense bush on the river's

bank." Sixteen flies were caught on the horses by "pinning their feet with a knife-blade (the best way of catching them, as they are as quick as lightning), and the Kaffirs securing some with their hands." The greater number of the flies were caught before doing any damage, and the rest were frightened away. The horses did not contract the disease. The native name for the fly on this river is "*impugan*" (pp. 410–411).

Low country between the Buzi and Pungwi Rivers infested with Tsetse-fly (1891).—"After this I was sent by the Company to try to find a route to the coast along the watershed between the Pungwi and Buzi rivers, free of 'fly' and therefore suitable for a waggon-road. But in this I was unsuccessful, as I found the whole of the low country between the Buzi and Pungwi rivers to be infested with the Tse-tse-fly" (p. 426).

Tsetse-fly near the Kasaia River [1888], an affluent of the Majili, which flows into the Zambesi about 20 miles above its junction with the Chobe.—"In the afternoon I continued my journey, and that night passed through an extensive mopani forest, to the east of the Kasaia River, in which the Tse-tse-fly still lingers, though in no great numbers" (p. 245).

Horses stampeded into the fly-infested mopani forest by a herd of zebras.—"The horses had twice passed through the fly-infested forest beyond the Kasaia, but as it was a cloudy day and a high wind was blowing, and the flies there are few and far between at this time of year, I do not think they were "stuck," and, at any rate, they never showed the slightest sign of being in any way affected" (p. 246).

Tsetse numerous in a strip of forest between the Magoi-ee (or Makoe) and Ungwesi Rivers, Batonga country (p. 215). [The Magoi-ee River "rises a little to the south of U-kesa-kesa, and runs north into the Kafukwi." The Ungwesi runs into the Magoi-ee.]

122. 1893. **Dr. F. Karsch.**

"Die bei Bismarckburg durch Dr. R. Büttner und (zum Theil) von Hauptmann Kling gesammelten, bisher bestimmten Hexapoden.—Dipteren": Ergebnisse der Forschungsreisen im Hinterlande von Togo 1890 bis

1892 von Hauptmann E. Kling und Dr. R. Büttner (*Mittheilungen von Forschungsreisenden und Gelehrten aus den Deutschen Schutzgebieten.* Mit Benutzung amtlicher Quellen herausgegeben von Dr. Freiherr von Danckelmann. VI. Band (Berlin, 1893. Ernst Siegfried Mittler und Sohn), p. 225).

"Glossina longipalpis (Wied.)" and "Glossina tabaniformis (Westw.)" [= *Gl. fusca*, Walk.] are included in the list of Diptera collected *in the neighbourhood of Bismarckburg, in the Hinterland of the Togo Protectorate*, W. Africa. The approximate geographical position of Bismarckburg is 8° 12′ N. lat., 0° 52′ E. long.

123. 1894. ——

La Nature (1), p. 286.

Note on *Glossina morsitans*. [I have not seen this.]

124. 1894. Dr. Donaldson Smith.

"Dr. Donaldson Smith's Expedition in Somaliland" (*The Geographical Journal*, Vol. IV., p. 530. London: The Royal Geographical Society).

A letter written by Dr. Donaldson Smith during his expedition to Lake Rudolf, and dated "Webi Shebeli (or Webi Erer?), lat. 7° 11′ N., long. 42° 11′ 23″ E., September 1–3 [1894]."

Camel-killing fly on the Webi Shebeli.

"I have seen one or two flies that I believe to be the dreaded Camel-fly of the Webi Shebeli, but they are very rare."

125. 1894. Commissioner Johnston (now Sir H. H. Johnston, K.C.B.).

"Report of the First Three Years' Administration of the Eastern Portion of British Central Africa." Dated March 31, 1894. [With five maps.] Presented to both Houses of Parliament by command of Her Majesty, August, 1894. (London: Harrison & Sons. Printed for Her Majesty's Stationery Office.) Pp. 18–19.

"Let us now consider the very important question of horses and cattle, and the possibilities of stock-rearing. Perhaps the greatest curse which nature has laid on this and other parts of South-Central Africa is the existence of the Tsetse-fly. Were it not for this the value of the country would be centupled. In the first place, the diffi-

culties of colonization would be solved, and also the difficulties of that conquest which must, sooner or later, take place if the slave-raiding tribes are to be kept under control. At present it is only over small and widely separated patches that horses and cattle can be kept free from the attacks of the Tsetse-fly. For instance, there is no Tsetse-fly on the road from Katunga to Zomba, a distance of over sixty miles. The convenience of this may be estimated from the fact that I can ride from Katunga to Zomba with a change of horses in two days, whereas it would take me three days hard and very uncomfortable travelling to perform this journey in a machilla.* On the other hand, I cannot ride over to Mlanje, which is only some forty miles distant, because there is a belt of Tsetse-haunted country in between. Neither can I ride the short distance of twenty-one miles to the Upper Shiré, for the same reason. Were it not for this, we could keep the whole Shiré province under control by a small troop of fifty mounted police. Nevertheless, we may be thankful that when proper precautions are taken it is quite possible, and not even very difficult, to introduce horses into the Shiré highlands. The Tsetse-fly appears never to go near the edge of a river or to fly over a river. Consequently, when horses and cattle are being brought up in steamers they are not attacked by the Tsetse as long as they do not leave the river; and, inasmuch as the piece of shore between Katunga and Chikwawa is free from Tsetse, we are able to land horses there and send them up into the highlands, where the fly is absent. By taking the horses down at night through the fly-belt between Zomba and the Upper Shiré to Mpimbi and embarking the beasts at once, they could also be got up to Lake Nyasa without being bitten. There is a considerable area round Fort Johnston and the south end of Lake Nyasa where there is no Tsetse-fly, and nearly all the country along the eastern shore of the lake is without this pest. On the contrary, the Tsetse occurs in patches along the west coast, but is quite absent from the north end of the lake. The southern shore of Lake Tanganyika is infested with the fly, which kills even dogs, goats and donkeys, the two latter beasts generally

* "A hammock carried by native porters.—H. H. J."

escaping. Yet over almost the whole of the region coloured brown on my sketch-map * the Tsetse-fly is absent. It is scarcely ever found above 3,000 feet. The Luangwa Valley, on the other hand, is full of Tsetse, so are certain portions of the Zambezi banks.

"There is one hope as regards the extermination of this fly, and that is, that it always dislikes the presence of human beings and avoids human settlements. It also seems to depend for its existence on large herds of game. Therefore, by the increased settlement and population of the country and the reducing the herds of wild animals, we may hope in time to exterminate the Tsetse to the same extent as it has by the past action of man been got rid of throughout the Soudan, where one never hears of it, and likewise in the regions of the Niger. It would be very interesting if the authorities at the British Museum would compile for use, from the information they possess, a map showing the distribution of the Tsetse-fly in Africa; I mean of course of that species of *Glossina*, the bite of which is fatal to horses, cattle and dogs. There are other species of *Glossina* whose bite is apparently innocuous. . . . Still, putting aside these occasional epidemics or endemic sicknesses, cattle do very well in such parts of South Central Africa which are free from the Tsetse-fly, and which are provided with good pasture" (p. 19).

126. 1894. Sir Gerald Portal.

"Reports Relating to Uganda by Sir Gerald Portal." Presented to both Houses of Parliament by command of Her Majesty, March, 1894. (London: printed for Her Majesty's Stationery Office by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty.)

Page 6.—Report by Col. Francis Rhodes to Sir G. Portal (dated "Kampala, April 2, 1893") "on the route between Mombasa and Uganda": "We were told on no account to bring ponies with us, as there was Tsetse-fly between Zavo and Kibwesi. We saw no sign of it, and the two ponies we brought with us did admirably, and improved in condition on the road."

* The Orography of British Central Africa.

127. 1894. **F. J. Jackson.**

"Big Game Shooting," Vol. I., pp. 185–186 (*The Badminton Library of Sports and Pastimes.* London: Longmans, Green & Co.).

No reason why horses should not be more generally employed in East Africa, "provided the belts of 'fly' country are avoided" (p. 185).

Tsetse-fly in East Africa not closely associated with big game.—"It is supposed by a good many people that the Tsétsé-fly only exists where game beasts, especially buffaloes, are most plentiful, and that the fly disappears as the game is killed off or driven away. This may be so in South Africa, but it is certainly not the case in East Africa, as the belts of fly country in East Africa are almost devoid of game, with the exception of the river Tana. As, however, the open, undulating, grassy plains of the Masai country, and other places of a like nature, are the headquarters of by far the greatest quantity and variety of game, and are entirely free from the Tsétsé-fly, and as they are also well adapted to hunting on horseback, the game would very soon be exterminated if pursuit on horseback were permitted . . . " (pp. 185–186).

128. 1894. **W. Cotton Oswell.**

"Big Game Shooting," Vol. I., pp. 113–115, 147, 150 (*The Badminton Library of Sports and Pastimes.* London: Longmans, Green & Co.).

"On the low Siloquana hills [in the north of the Transvaal, between the Magalaqueen River and the Limpopo] near this we made our acquaintance with the Tsétsé-fly, which we were the first to bring to notice [the year referred to is 1845]; Vardon taking or sending to England some he caught on his favourite horse."—Symptoms and effects of the bite of the fly on cattle (p. 113).

"Wild animals are not affected, but all domestic ones are, save the ass and the goat, and the calf as long as it sucks. Man escapes scot free. The flies settle on him and bite him sharply, but no results follow" (pp. 113–114).

"This pest, like all others, is held in check by an antagonist, one of the ichneumons—a rakish-looking creature which catches and sucks it out on the wing, dropping

the empty cases much as the locust bird does the locusts" (p. 114).

[The insect here referred to as attacking the Tsetse is probably one of the Asilidæ—a family of Diptera, the members of which prey on other insects in the manner indicated. The Ichneumonidæ are Hymenoptera, which lay their eggs in living caterpillars, but do not themselves hawk after insects.—E. E. A.]

Cattle take their death-bites quite calmly—"with a whisk of their tails, as is their custom with other flies" (p. 114).

Tsetse on the Chobe River, in the bush, not in the reeds: the flies begin to buzz about as the sun rises (p. 147).

"We had travelled all night through the sleeping flies" (pp. 146–147).

"Livingstone woke up, smoothed down my visitor, and inquired what we could do with the cattle. We could not leave them where they were; they would find nothing to eat, and besides, when the sun got hot the flies would find their way to them. We must drive them across the river, as there were no Tsétsé there, the man told us; and we found that it was so, the narrowest lines frequently defining the limits of safety and danger" (pp. 147–148).

"The Tsétsé, that great enemy to the cattle-breeder, will disappear before the approach of civilisation, and the killing off of the game, especially the buffalo, its standing dish, as it has done many times already in African lore. I am speaking of the tracts south of the Zambesi" (p. 150).

129. 1894. Jules de Guerne.

Compte-Rendu Sommaire de Séance de la Société Philomathique de Paris.—Compte-Rendu Sommaire de la Séance du 14 *Avril* 1894, No. 12, p. 2.

Report of the exhibition of two specimens of *Glossina morsitans*, Westw., collected in Central Africa by M. Édouard Foà.

[Translation.] "Everything leads us to believe that *Glossina* inoculates domestic animals with the germs of some virulent malady analogous to anthrax. . . . No doubt it would be possible to cultivate the bacteria

disseminated by the insects, attenuate their virus, and perhaps also find a new vaccine capable of saving the animals necessary for the prompt colonisation of Central Africa."

130. 1895. E. Corti.

Annali del Museo Civico di Storia Naturale di Genova, Serie 2.ª, Vol. XV. (XXXV.), pp. 138–139.

Original description of *Glossina longipennis*, from Somaliland.

131. 1895. Surgeon-Major David Bruce, A.M.S. (now Lt.-Col. David Bruce, R.A.M.C.).

"PRELIMINARY REPORT ON THE TSETSE-FLY DISEASE, OR NAGANA, IN ZULULAND" (Durban: Bennett & Davis, Field Street), 28 pp.

[I have not seen this *Preliminary Report*: it was reviewed by W. F. H. Blandford, in *Nature*, April 16, 1896. For the "Further Report," see below [142], and also Chapter VII., Appendix A.]

132. 1895. A. Whyte.

"REPORT ON THE BOTANICAL ASPECTS OF BRITISH CENTRAL AFRICA." Foreign Office, 1895. Miscellaneous Series, No. 373. Reports on Subjects of General and Commercial Interest. Africa (Central). — (London: printed for Her Majesty's Stationery Office, by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty.)

Tsetse-fly (pp. 16–18).

"This is a pest which will seriously interfere (for some time at least) with the introduction and rearing of domestic stock, and thus form a drawback to agricultural enterprise" (pp. 16–17).

Notes on specimens in the British Museum, with information furnished by E. E. Austen.

133. 1895. Major H. S. Mainwaring.

"THE KORAYO VALLEY, SOMALILAND" (*The Geographical Journal*, Vol. VI., p. 474. London: The Geographical Society).

Tsetse-fly (?) *in the Korayo Valley*, 1894.

"The Korayo valley, placed by Major Mainwaring north-west of the Tug Turfa or Turfo, would seem to be

that of the Erer, visited lower down by Dr. Smith. . . ." 'The valley itself is described by the latter [Major Mainwaring] as quite the Eden of Somaliland, being thickly wooded, and the tops of the smaller hills covered with fresh green grass. At the bottom of the valley were found a running stream, luxuriant tropical vegetation, brilliant-plumaged birds, and bright flowers. It is unfortunately infested by a fly, apparently a species of Tse-tsi, which proved fatal to the animals."

134. 1895. W. A. Eckersley.

"Notes in Eastern Mashonaland" (*The Geographical Journal*, Vol. V. London: The Royal Geographical Society).

Appearance of the Tsetse-fly at Chimoio, Portuguese East Africa, on the line of the Beira Railway in 1894: *two ponies taken by the survey party in* 1893 *through the fly-belt to Chimoio without suffering any ill effects.*

"The temporary terminus of the railway, usually known as the 'Seventy-five mile peg,' is 43½ miles from Chimoio by the line recently surveyed for the proposed extension to that point; the distance measured in a straight line is very considerably shorter. The Seventy-mile terminus is connected with Chimoio by a waggon road lately cut through the forest, thus bringing the railway into direct communication with the 'Selous' road to Massi-Kessi, Umtali, and Salisbury. The terminus is unfortunately situated well within the limits of the district infested by the 'Tsetse-fly,' thus rendering imperative the early extension of the line to Chimoio, or even further to the west. Chimoio, up to the present, has been entirely free from the fly. The doubt has been expressed that the presence of a large number of horses, oxen, and other animals at Chimoio, attracted thither by the facilities of transport offered by the railway, might in its turn be the means of attracting the destructive fly to that place. This doubt has now become a certainty, recent letters containing the news that the dreaded fly had actually made its appearance in Chimoio.

"It is interesting to note that two ponies, purchased in Natal for the use of the survey party, passed through Beira, Fontesvilla, and the intervening 'fly-belt,' to

Chimoio without suffering any ill effects; they served the party until the conclusion of the work, and were finally sold at a profit. No particular precautions against the 'fly' were adopted, except occasional brushing with green boughs. It is quite certain that the Tsetse-flies settled on the horses in considerable numbers, and remained quite long enough to allow of their biting. It was only during one day, however, that the flies were present in large numbers; this was on the course of the railway, between 38 and 45 miles from Fontesvilla.*

"For the first 20 miles the line of railway traverses a perfectly flat, nearly treeless, alluvial plain, covered with long grass and teeming with big game, including lions, buffaloes, most of the South African species of antelope, wart hogs, and wild boars" (p. 29).

Tsetse-fly in Mashonaland.—"White ants and borers are the worst enemies of the settlers in the high country, while the Tsetse-fly causes incalculable mischief in the low-lying districts" (p. 38).

135. 1895. Édouard Foà.

"Mes Grandes Chasses dans L'Afrique Centrale" (Paris: Librairie de Firmin-Didot et Cie), pp. 22, 28–33, 220–221.

[Translation.] "The day of our arrival on the banks of the Crocodile River, we were on the eve of our troubles. . . . There was something more, that we learnt next day: we were entering the region infested by the terrible Tsetse-fly, and we must expect to meet with it at any moment. It would be the death of our oxen; there was no remedy in our power, we could only resign ourselves to our fate" (p. 22).

"There is nothing repulsive or remarkable in its [the Tsetse's] appearance to anyone who does not know it; its flight is exceedingly quick, and it is impossible to distinguish it in the air before it has fed; when its abdomen is full of blood, its flight becomes heavy and it at once hides itself in order to digest its meal in peace. Owing to its quickness, it is impossible to catch it like an ordinary fly. When it settles, it does so so gently that one does not feel it; it remains thus motionless for fifteen or twenty seconds,

* The starting-point of the Beira railway.

its proboscis projecting in front, in a mistrustful attitude, ready to take flight. When it believes itself safe, it lowers its weapon, separates its feet so as to flatten itself out more and pierces the flesh without causing any pain to start with, as does the mosquito. . . . While its proboscis, which is at least a quarter of a centimetre in length, disappears completely in the flesh, it remains motionless sucking blood, its abdomen swelling and becoming rose-coloured owing to its transparency, and immediately afterwards appearing deep red and plump. It is not until the moment when it has already imbibed a large portion of its meal, that a slight pain or rather itching betokens its presence. When its stomach is full it is still very difficult to catch with the hand, for it does not fly off, but quickly dodges to one side. The natives and I myself, when they showed me the way, used to catch it in a different fashion: the blade of a knife is laid at a distance of 30 centimetres from the fly flat on the arm or on whatever part of the body it has settled, and is then slowly slid along until it meets and squeezes the proboscis of the fly still buried in the flesh and thus makes the insect a prisoner*; then, without relaxing the pressure, you raise the blade and turn it over, and so kill the fly, or else seize it with the fingers. Of course you have already been bitten by the fly, but you console yourself by thinking that, at any rate, there is one enemy less among the surrounding thousands.†

"I have now to speak of the sensations occasioned in domestic animals by its bite. Of these animals, I shall mention those that one has to possess in Africa: the ox, dog, donkey, mule, sheep, pig, and goat. Livingstone states that the latter and sometimes the donkey are exempt from the consequences of the bite, while all the other animals die from it. I am able to state, after having made several experiments, that none of the animals I have mentioned survives it; it depends simply and solely on the number of the bites. The local fauna is inoculated with the poison of the fly from its youth up; it is moreover from it that the insect obtains its food; but when

* In Sierra Leone my Timminy hammock-boys used to catch Tsetse-flies (*Glossina palpalis*) in the same way.—E. E. A.

† "This way of catching it with a knife seems to prove that the Tsetse does not see in front of and below it."

the Tsetse accidentally meets with domestic animals, it pursues them with peculiar pertinacity; the animal has an instinctive sense of the danger that threatens it: it jumps, shies, and after the first bite, the noise alone of the fly literally deprives it of its senses; it loses its head and bolts, hoping in this way to outstrip the murderous insect buzzing round it. The venomous fly comes to its prey from a long distance, whether it is that its sight is keen or its sense of smell exceptionally acute; I would incline rather to the latter hypothesis, since I have noticed that the fly always comes up wind, and generally bites by preference on the leeward side. The Tsetse keeps on the under, not on the upper side of leaves, as one never sees it, and it prefers shade to sun. It especially dislikes the odour of excrement; as soon as an antelope is killed, for instance, in order to get rid of the Tsetse which literally cover game and hunters, it is only necessary to open the animal's belly and evacuate the entrails; the insect at once ceases to torment you" (pp. 29–31).

Symptoms of Tsetse-fly disease in cattle (pp. 31–32).

The interval that elapses before death depends upon the number of bites (p. 32).

The Tsetse follows the big game, of the existence of which in a district its presence is a proof. "It is particularly partial to buffaloes and the large antelopes; that is why one finds districts containing small game devoid of Tsetse." The fly will disappear simultaneously with the destruction of the big game (pp. 32–33).

"I have still to speak of the sensations experienced by a human being after being bitten by the poisonous insect. The itching feeling changes in a few seconds to a painful pruritus which lasts about a quarter of an hour; the bitten part reddens, swells slightly, and continues to be uncomfortable for a short time (*pendant un moment*). A large number of bites may undeniably have a disturbing effect upon the organism; above all, they have the effect of exciting one excessively, and a feeling of rage is added to the suffering. The parts affected by the fly in the case of man are generally those that are uncovered: hands, arms, neck, cheeks, and legs, always on the under side as much as possible" (p. 33).

Swarms of Tsetse on the Kapotché River.—"The momentary sense of comfort experienced in this wood was very quickly forgotten; never had I seen round us such swarms of Tsetse; it was simple torment and it was impossible to remain seated. The accursed insects seemed to be particularly infuriated with us, and each one of the 200 men had a large detachment to himself.

"I found it impossible to breakfast; one was bitten on the arms, legs, neck—in twenty different places at once. I had with me a tame goat, who was very amusing. . . . The poor beast died under a swarm of Tsetse, in the space of an hour: maddened by the bites, he had begun by rolling on the ground, then foam gathered on his lips, his belly became swollen, and, when I noticed what was happening, he was already dying.

"After a few hasty mouthfuls, I caused the camp to be struck and everyone was very glad to be off. Never had I seen so many Tsetse together in the same spot. This must be their village, as Maonda said. We left there the body of my goat, whose sufferings I had terminated by a knife-thrust" (pp. 220–221).

136. 1896. W. F. H. Blandford.

"The Tsetse-Fly Disease" (*Nature*, No. 1381, Vol. 53, April 16, 1896, pp. 566–568, Figs. 1 and 2: wood-cuts of *Glossina sp.*, larva, puparium, and hæmatozoa of Nagana in the blood of a horse).

A review of Surgeon-Major Bruce's *Preliminary Report on the Tsetse-fly Disease, or Nagana, in Zululand.*—[*Vide supra*, 131.]

137. 1896. ——

The Field, April 11, 1896. An article on the Tsetse-fly.

[I have not seen this.]

138. 1896. Sir Harry Johnston, K.C.B.

Report by Commissioner Sir Harry Johnston, K.C.B., on the Trade and General Condition of the British Central Africa Protectorate. April 1, 1895, to March 31, 1896. [With a Map.] Presented to both Houses of Parliament by command of Her Majesty. August, 1896. (London: Printed for Her Majesty's

Stationery Office by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty.)

"We must encourage the unchecked increase of the negro population in British Central Africa, for the presence of millions of men with strong arms, and relatively proof against malarial fever, or, at any rate, amongst whom life is very cheap, will soon dispel malaria, the Tsetse-fly, and other drawbacks to the utility of British Central Africa. . . . The Tsetse-fly loathes the presence of man, and is already fast disappearing from the Protectorate. It is never, in any case, found in the hills, and we have only to get those great riverain plains and lake shores densely peopled to be able to chronicle its entire extinction" (p. 12).

Disappearance of the Tsetse-fly from the country to the south of Lake Nyasa.—The bringing down of cattle from Lake Nyasa to Blantyre "has shown in many cases how completely the Tsetse-fly has disappeared from regions where formerly its presence in large numbers would have killed almost all the cattle that crossed the infested territories" (p. 15).

139. 1896. **J. W. Gregory.**

"The Great Rift Valley" (London : John Murray), pp. 21–22.

Tsetse-fly in belt of forest between Witu and the coast.—"There were no preparations for firing the belt of forest at Pangani through which the road passes, and which is the haunt of the Tsetse-fly (*Glossina morsitans*, Westw.). On the journey through it on our way up, I had found this dreaded fly. To expose our camels to an attack from it was to risk the whole safety of the caravan; I had therefore sent back a note to say that before the baggage animals entered this belt of forest, fires ought to be lighted in it and the animals driven through the smoke. This is the method commonly used to protect animals when passing through a fly-haunted district. I found out afterwards that the Galla in the Tana valley know all the fly-infested patches, and always adopt this precaution when driving their cattle through them. As Dr. Rae seemed better, he went on with two men, and I stopped there to prepare the fires, sending on a note urging that

these should be lighted half an hour before the camels were allowed to enter the forest. The rest of the day was spent in building up stacks of wood and dead leaves; these were arranged as far as possible on the model of the 'smudge-fires' used in Manitoba to protect the wheat from the early frosts of August, by raising a cloud of smoke above the fields."

140. 1896. W. Dönitz.

Berliner Entomologische Zeitschrift, 41. Band, pp. (17)–(18).

Report of a paper on Tsetse-flies, containing a summary of previous statements.—No new facts.

141. 1896. Alfred Sharpe.

"The Geography and Resources of British Central Africa" (*The Geographical Journal*, Vol. VII.). (London: The Royal Geographical Society).

Tsetse-fly absent from the highlands of British Central Africa.—"In the high parts of B.C.A. cattle and horses thrive, and there is no Tsetse-fly" (p. 384).

142. 1897. Surgeon-Major David Bruce, A.M.S. (now Lt.-Col. David Bruce, R.A.M.C.).

"Further Report on the Tsetse-Fly Disease or Nagana in Zululand." Ubombo, Zululand, 29th May, 1896. (London: Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty. 4th February 1897.) 69 pp., Plates I–VI.

[See Chapter VII., Appendix A.]

143. 1897. Captain A. St. H. Gibbons.*

"A Journey in the Marotse and Mashikolumbwe Countries" (*The Geographical Journal*, Vol. IX).

Tsetse-fly swarming on the banks of the Zambesi, 35 miles above Sesheke, July, 1895.—"Some 35 miles from Sesheke brought me to high banks covered with forest and teeming with Tsetse-fly. Such is the general character of the river as far as the southern extremity of Borotse" (p. 123).

Tsetse-fly absent from the Borotse "Valley," which extends along both banks of the Zambesi from 16° 15′ *S. lat. to considerably beyond Lialui.*—"On the second day after this I reached the southern extremity of what is frequently

* *Cf.* [152].

described as the Great Borotse 'Valley' (16° 15′ S. lat.). Livingstone first spoke of the Borotse as a 'valley,' though 'plain' or 'flats' would convey a more correct idea of what in reality is a huge treeless alluvial plain in places 50 or 60 miles wide, and extending a very considerable distance to the north of Lialui, which stands 70 miles as the crow flies from the southern boundary of the plain. In the winter season the Borotse yields an excellent cattle pasture, and, being free from the 'Tsetse'-fly, supports many thousand head of cattle" (p. 126).

Tsetse-fly absent from the grassy valley through which flows the Njoko River, above and below its confluence with the Rampungu (p. 134).

144. 1897. **Sir A. Hardinge.**

"Report by Sir A. Hardinge on the Condition and Progress of the East Africa Protectorate from its Establishment to the 20th July, 1897." [With Map.] Presented to both Houses of Parliament by command of Her Majesty. December, 1897. (London: Printed for Her Majesty's Stationery Office by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty.)

"It may appear somewhat remarkable that the Province of Ukamba, the most uncivilised division of the territory, should be the best supplied with roads, but it must be remembered that the coast provinces carry on their communciations with one another to a great extent by sea, and secondly, that over a large portion of them the climate conditions and the presence of Tsetse-fly preclude the animal transport by carts, which in the interior is the great incentive to road-making. In Witu, for instance, where the Administration built a good carriage-road from the capital to the Port of Mkunumbi, the bullocks employed for the waggons on it all died, and the old wretched system of human porterage has still to be resorted to for transport, even donkeys not being procurable in sufficient numbers" (p. 51).

"Along the Uganda Road transport by carts drawn by bullocks has been successfully initiated. Between Mazeras and Kibwezi there are, however, several tracts infested by Tsetse. . . ." (p. 52).

Cattle flourish in Ukamba (p. 52).

145. 1897. **Sir H. H. Johnston, K.C.B.**

"British Central Africa" (London: Methuen & Co.), pp. 54, 64, 367, 377–380.

In Chapter III., dealing with the "History" of British Central Africa, the author writes (p. 56):—"At first Sena, on the Lower Zambezi, was the headquarters of the Portuguese Administration, and from hence various expeditions, during the sixteenth century, were sent southwards to discover the gold mines of Manika—expeditions which were mostly unsuccessful, owing to the unhealthiness of the climate and the presence of the Tsetse-fly."

Indian buffaloes, introduced into Africa by Livingstone, not affected by the bites of the Tsetse-fly.—"Livingstone also tried [in 1866] to introduce the Indian buffalo,* an experiment not repeated until my reintroduction of this animal from India in 1895. It is interesting to note that Livingstone's buffaloes passed through the Tsetse-fly country, and, seemingly, were not affected by the bites of that insect, though they all subsequently died as the result of maltreatment at the hands of the sepoys" (p. 64).

"And now we come to the Tsetse, perhaps the most serious of all the many insect pests of Africa in its check to European enterprise. It is difficult to overestimate the importance of the part played by this noxious little insect in preventing the opening up of Central Africa.

"This was first experienced by the earlier Portuguese expeditions of five hundred or six hundred mounted men which would set out from Sena on the Lower Zambezi in the sixteenth and seventeenth centuries to secure the gold mines to the north and south. We read in Portuguese records how their horses soon succumbed to the attacks of a fly. The riders were left without steeds and the expeditions came to an abortive termination, many of the Europeans dying of fever or succumbing to the attacks of the natives through having to make their way on foot. But for the Tsetse-fly the whole history of South-Central Africa would be different. It would have been rapidly traversed by mounted men, not nearly so much ill-health would have pursued explorers and pioneers forced to travel on foot, and the whole question of transport would be rendered infinitely more easy, as coaches and waggons

* *Cf.* [49].

could run and huge numbers of pack-animals—horses, mules and oxen—might convey goods which at present are carried on men's heads. Undoubtedly the Tsetse-fly has checked the southward range of the Muhammadan raiders from the north. But for the presence of this insect in the Congo Basin and in Equatorial East Africa, the Muhammadanised negroes and Arabs of the Sudan would have spread much farther south than they have done already on their sturdy little ponies" (p. 377).

"Fortunately the Tsetse-fly is not present in all parts of British Central Africa. Roughly speaking, it may be said that it is absent from any district that is above 3000 feet in altitude, and is not found in many of the low-lying lands for some hitherto unexplained reason, no doubt connected with human settlement. It is present throughout the whole valley of the great Luangwa River from the Zambezi to the verge of the Nyasa-Tanganyika plateau. It is found on part of the upper course of the River Luapula and on the shores of Lake Mweru, but is absent from the greater part of the country round Bangweolo. It is most abundant on the south coast of Tanganyika, disappearing, however, as soon as the slopes of the Nyasa-Tanganyika plateau are reached. On Lake Nyasa it is absent from almost the entirety of the east coast. On the west coast it is met with between Deep Bay on the north and the River Bua on the south, some patches in between, however, being free from it. From about Kotakota and the Marimba district it is absent. It reappears again south of the Marimba in the northern part of the coastlands of the Central Angoniland district. From the south coast of Lake Nyasa it is almost entirely absent, but it is found again on a small portion of the Upper Shire.

"In the low-lying country round Lake Chilwa up to the slopes of Mlanje and the hills near Zomba it is present. On the Central Shire at Chikwawa and Katunga there is no Tsetse, but in the Elephant Marsh below it abounds, as also in much of the Ruo district and in the district of the Lower Shire. Always, however, when the land rises to 3000 feet and beyond the Tsetse disappears. This insect has a great dislike to water and a still stronger dislike to a congeries of human habitations. In conse-

quence, it is possible to convey horses and cattle up the rivers without the least danger of their being bitten, as long as they remain on the boat anchored in mid-stream. They are also quite safe in the middle of any collection of huts or in any town. It is a fortunate thing that there is no Tsetse at Katunga or Chikwawa on the Central Shire, as live stock can be brought the whole way by water to this place from the mouth of the Zambezi,* landed there and sent up to Blantyre, and can thence be conveyed by various routes which are free from Tsetse-fly to the Upper Shire and so on to Lake Nyasa. Another important fact to be borne in mind is that the Tsetse-fly does not bite at night, therefore if a Tsetse-haunted district must be crossed it should be done at night-time—by moonlight if possible. It is said also that smearing the bodies of the animals with cow-dung will repel the insect" (pp. 377–378).

[Five sketches of Tsetse-flies, 1½ times life size, are given on p. 378, but are not sufficiently accurate to be useful.]

"Donkeys are far less subject to the poisonous character of its bite than horses or mules; indeed, it is said that the domestic donkey of East Africa, which is only one degree removed from the Abyssinian wild ass, is impervious to its attacks, and certainly none of those animals have died from Tsetse bite in British Central Africa. Major Lugard, I believe, has found on his expedition to Lake Ngami that his donkeys were the only animals that survived the attacks of the Tsetse. Dogs are killed by it, and even cats will not resist its attacks when too frequent. On the Mwanza River, an affluent of the Shire nearly opposite to Katunga, the Tsetse are so numerous that the only domestic animals which can be kept by the natives are fowls" (p. 379).

Notes on the distribution of Tsetse-flies in Africa generally, from specimens in the British Museum (p. 379).

"In the greater part of the Nigerian, the Central and the Egyptian Sudan the Tsetse is absent, thus permitting a far more rapid and healthy development and conquest of these countries, as horses are abundant and can be employed to mount cavalry and transport travellers, while

* "The Tsetse is apparently absent from Chinde and Quelimane and much of the Zambezi Delta."

for trade purposes mules and oxen can be employed, and an unlimited number of cattle might be reared" (p. 379).

Theories as to the nature of the "Tsetse poison" discussed (p. 379).

"Certainly the Tsetse tends to disappear before the presence of man, and the one certain cure for it would seem to be the placing of all the low-lying parts of British Central Africa under cultivation, and the settlement of innumerable negroes. Fortunately the fly does not much trouble our political economy, for the further reasons that so much of the country lies above its habitat. In those districts where it is healthy for Europeans to settle, the altitude is already too great to permit of the existence of the Tsetse-fly" (p. 380).

146. 1897. Lieut. Th. Masui and — Seeldrayers.

"Guide de la Section de l'État Indépendant du Congo à l'Exposition de Bruxelles-Tervueren en 1897" (Bruxelles: Imprimerie Veuve Monnom), p. 300.

The common house-fly [Musca domestica, L.] *said to cause the Tsetse to disappear!*

[Translation.] "We will not speak of the fly of Europe, which is already acclimatised everywhere, and, it seems, should have the advantage of bringing about the disappearance of the Tsetse, that enemy of stock. . . ."

Further on, pp. 306–310, horses, donkeys, and mules, all three of which have been introduced, and cattle, goats, sheep, and dogs are mentioned as existing in the Congo Free State, and nothing is said as to their suffering from the attacks of the Tsetse-fly.

147. 1897. Édouard Foà.

"Du Cap au lac Nyassa" (Paris), p. 148.

[*Apud* Laveran & Mesnil, "Recherches morphologiques et expérimentales sur le Trypanosome du Nagana," etc., p. 5, note 2.]

"There cannot be any doubt as to the harmlessness of the bite of the Tsetse in the case of wild animals, especially buffalo and the large antelopes" (p. 148).

According to Laveran and Mesnil the author states that he was bitten thousands of times by Tsetse-flies, without experiencing anything beyond very slight local effects, and a feeling of irritation against the fly.

148. 1897. Mary H. Kingsley.

"Travels in West Africa" (London: Macmillan & Co.).

Tsetse-fly on the Gold Coast.

A made road running up country on the Gold Coast "cannot be of use for draught animals, because of the horse-sickness and Tsetse-fly which occur as soon as you get into the forest behind the littoral region" (p. 637).

149. 1897. Aurel Schulz, M.D., and August Hammar.

"The New Africa: A Journey up the Chobe and down the Okovanga Rivers. A Record of Exploration and Sport" (London: William Heinemann), pp. 67–68.

Tsetse-fly on the swampy off-shoots from the Chobe River, July, 1884.

"Oh, those horrid swamps, worse for the reason that our donkeys were badly Tsetse-fly bitten, and the immersion of their hides in the water would inevitably hasten their death, although donkeys show more resistance to 'fly-bite' than any other domestic animals. But, given such swarms of 'fly' as we encountered, even this hardy brute will succumb, as ours eventually did, to the virulence of this pest. It has often been asserted, not without mild proof, that the donkey of all domestic animals is the only one that will survive the Tsetse-fly bite. I myself have seen them traverse safely the distance from Delagoa Bay to Lydenburg in the Z. A. R. in 1874, when that country was thickly infested with flies that killed cattle, horses, and even the few camels that were imported as an experiment. But when bitten by such overwhelming swarms as we experienced, poor Jack and Jenny succumb in the usual way. The most sensitive animal to fly-bite is the horse, then the dog, next the ox, and last the donkey. The bites of five Tsetse-flies have been known to kill a horse, while it takes a much larger number to kill a dog or ox. Experiments have been made by travellers to counteract the effect of fly-bite by a wash of ammonia or sheep dip. Whatever effect these may have for the moment, the subsequent and continuous bites generally are victorious in the end. My esteemed friend, Mr. Reuben Beningfield, of Durban, however, declares that he has cured animals only slightly bitten, and

hastily isolated from further molestation, by a wash composed of ingredients only known to himself.

"The 'fly' poison is injected into an animal in the same manner as the mosquito bites, and leaves a small diffuse lump on the bitten spot, causing much local irritation, especially as the fly attacks the least exposed parts of the animal, where the skin is thin, and it cannot be driven away by the tail. The bite is much aggravated by contact with water, and it is a well-known fact that the early rains carry off all fly-bitten cattle. The bitten animal shows signs of great lassitude, its head swells, and the joints and limbs become stiff. At this stage a merciful bullet is advisable to forestall a death of general debility and asphyxia. On cutting the beast open, one finds the subcutaneous tissue injected with a yellow serous fluid not unlike the result of some snake bites, and also the lungs injected. Beyond this I have not been able to investigate, as these episodes usually occur on a march when neither time nor opportunity is offered for scientific observation.

"The goats we had with us showed no signs of being affected by fly-bite, and I feel safe in the assertion that they are impervious to this poison. To mankind and all wild beasts the bite is innocuous, although surprisingly unpleasant in its sting, equal in quality to that of a good healthy wasp or bee. To illustrate the violence of the bite, let me relate that on one occasion I had already sighted the rifle at a buffalo standing looking at me some thirty yards off, and was just in the act of pulling the trigger, when a Tsetse-fly settled on my hand, and the sting was so acute that I had not the nerve to pull the trigger, but had first to brush the fly off, and by the movement scared the buffalo away.

"The fly on the Pungwe River is, I think, slightly smaller and darker in hue than those on the Upper Zambesi or Chobe rivers" (pp. 67–68).

On the Chobe, August, 1884.—Death of a donkey from "fly-bite": "the other two were almost unable to walk from stiffness brought about by the same cause" (p. 163).

"Jumbo the big donkey showed severe symptoms of fly-bite on the 13th August. In the morning he was quite stiff and unable to rise, but after being set on his

feet, struggled about until the stiffness went off a little and he was able to get about and graze. In the evening he was able to walk a little. A diffuse swelling extended from between the hind legs, reaching along the belly up to the forelegs. Otherwise there appeared to be no distress in breathing, or any increased temperature judged by feeling the ears" (p. 167).

150. 1898. **Prince Nicholas D. Ghika.**

"Cinq Mois au Pays des Somalis" (Georg & Co.: Genève et Bâle), pp. 131–132.

Tsetse-fly destroying cattle and horses in the Aulihan Country, Somaliland (on the north bank of the Prince Ferdinand River, and south of the Webi Shebeyli), in January, 1896.

[Translation.]—"Another consideration inclined us to listen to them; that is to say the presence, in the Aulihan Country, of the Tsetse-fly: one after another several camels have succumbed to its bites, and this very morning one of our horses collapsed suddenly (*est tombé foudroyé*) at the moment that it was being bridled; another, also bitten, is so ill that it cannot be long before it has to be left by the wayside."

151. 1898. **A. H. Neumann.**

"Elephant-Hunting in East Equatorial Africa. Being an Account of Three Years' Ivory-Hunting under Mount Kenia and among the Ndorobo Savages of the Lorogi Mountains, including a trip to the north end of Lake Rudolph" (London: Rowland Ward, Limited), pp. 8, 28, 142, 145, 160, 161, 162, 163, 282.

December, 1893.—*Mombasa to Laiju* ("a district on the north side of the Tana, and close to the foot of the Njambeni or Jambeni range, which is a little east of Mount Kenia").—"I ventured to disregard advice to take the Tana River route—involving a sea voyage, a fresh organisation, and a journey through difficult and unhealthy 'fly'-infested bush all the way, with little useful help from canoes (which could not take animals) against the stream—and elected for the overland one through northern Ukambani" (p. 8).

Return to Laiju, April 14, 1894.—"The news that awaited me was far from cheering. Although before I left

many of my donkeys were already dead, I had hoped that when those that had suffered most from 'fly' in passing through the Tana valley* had succumbed, the remainder would keep healthy; for I did not then know that Laiju was one of the most deadly places in Africa for domestic animals, not excepting the generally hardy ass. But on my return now I found that all were either dead, dying, or sick" (p. 28).

On the south bank of the Athi River, above its junction with the Tsavo, May, 1895.—"It is pleasant to get on the banks of this river (for which I always retain an affection), with its green willows and fresh scent, and its wide, though shallow and rather muddy, stream, and to have an unstinted supply of good sweet water. . . . The river runs through the same barren, scrub-covered country—in some parts gravelly ridges, in others sandy flats bordering its banks. . . . One thing that strikes me about this country is the scarcity of game; for even along the banks of the river there is marvellously little—a very few waterbuck at intervals, an occasional lesser koodoo or two, a little lot of impala, sometimes, at one particular point, and rarely an odd bushbuck, are all that is seen, without counting the diminutive paa, and now and again a rhino, giraffe, or hippo spoor. Formerly there was a sprinkling of buffalo in small herds; but these the cattle-plague swept off. The other game, however, was always scarce. It is easy to say that the conditions are not suited to its requirements—too much scrub and too little grass—but one cannot help wondering why some species have not become adapted to the land. Here are great stretches of uninhabited bush country with a perennial river running through it, and hardly any animals, though plenty of birds and of 'fly' (Tetse)" (pp. 141–142).

July, 1895.—Tsetse "very numerous" in thick bush to the north of the Tana (approximate geographical position, from the author's map, 0° 10′ S., 38° 10′ E.) (p. 161).

July, 1895. *Laiju to northern extremity of Jambeni hills.*—"The number of my donkeys was reduced somewhat, as one by one they succumbed to the effects of the 'fly' we had come through; the numerous streams, too, caused much delay and trouble with the pack-animals;

* [A "wide shallow valley full of monotonous dense scrub" (p. 10).]

but, when once the point of the Jambeni hills is weathered, the country becomes more open and the grass less rank, and from there onward it is healthy for them" (pp. 161–162).

December, 1895. *On the eastern shore of Lake Rudolph, near the northern end.*—"Another frequent and disagreeable accompaniment of abundant game was a fly, two specimens of which I caught, that I have always taken for the female of the 'Tetse,' though in this I may be in error. It is larger than the typical one and of a uniform brownish colour with no markings, but in other respects exactly similar both as to appearance and habits,* and I have always before noticed it associated with the smaller striped variety, though I saw none of the latter kind here. Whether this kind is poisonous or not I am not sure. My donkeys never suffered from having passed here; but then they can stand a *few* 'fly,' though where the 'Tetse' is numerous they soon succumb" (p. 282).

152. 1898. Captain A. St. H. Gibbons.†

"Exploration and Hunting in Central Africa 1895–96" (London: Methuen & Co.), pp. 61–65, 225, 228, 326.

On the left bank of the Njoko River, near its confluence with the Zambesi, August, 1895.—"Many of the northern tributaries of the Zambesi, unlike the dry sand rivers of South Africa, flow through wide alluvial valleys, occasionally quite 1000 yards in width. These valleys, though dry in winter, become swampy in the rainy season. The rich soil produces excellent cattle pasture, capable of sustaining vast herds in those districts which are not infested by the Tsetse-fly. This cruel little pest is particularly numerous on the lower reaches of the Njoko River.‡ The excessive attention they paid to the back of my neck resulted in boil-like lumps, which at one time threatened to give much pain and inconvenience; but zinc ointment and a protecting handkerchief proved a rapid and efficacious remedy.

* [The fly here alluded to is obviously *Glossina fusca*, Walker, one of the two *large* species of Tsetse-flies: the other large species is *Glossina longipennis*, Corti, which is found in Somaliland.—E. E. A.]

† *Cf.* [143].

‡ [Latitude, according to author's map, 17° 8′ 4″ to 17° 4′ 5″ S.]

"The Tsetse is in reality very little bigger than the English house-fly, though his wings being longer he appears to be much larger. The fore part of the body is so hard that more than an ordinary pinch is necessary to deprive this insect of life. I have frequently thrown flies away for dead after giving them a vigorous squeeze, only to see them fly away before reaching the ground. . . . The proboscis of the Tsetse protrudes in a horizontal direction and does not point downwards, as is the case with other flies. It is about one-eighth of an inch long, and penetrates the skin through a thick flannel shirt without an effort. The fly is frequently to be heard giving vent to the high-pitched buzzing note which gives it a name, but when advancing to attack he noiselessly makes straight for his mark without all the preparatory fuss employed by others of his genus. His tread is so light that the sharp prick of the proboscis is generally the first indication of his whereabouts. The Tsetse avoids open plains and is only to be found in forest or bush, and even there the limits of his habitat are so clearly defined, and the fly-belts so permanently established, as to give rise to much speculation as to the reason why one of two contiguous districts of a similar character should teem with 'fly,' while the other is quite free from the pest. Certainly where buffalo is thick the Tsetse is numerous—generally, at least—but this rule does not necessarily apply to most game. Districts occur in which game abounds, which, though within measurable reach of fly-belts, are perfectly free of their presence. There is much mystery and consequent speculation about the nature and peculiarities of the Tsetse. Hard facts are known well enough, but the scientist has not yet arrived on the scene who can explain its *raison d'être* and the paradoxes of its nature. It is commonly supposed in South Africa that the fly lays its ova in the skin of the wild buffalo, but this is not so, as experiments by Mr. Trimen, formerly curator of the Cape Town Museum, have proved; still, where the wild buffalo is to be found in large numbers the Tsetse invariably teems, and yet the domestic ox succumbs more readily to the bite than any other animal, except perhaps the horse, whose first cousin the zebra wanders through belts unhurt. So, too, the wild dog and jackal are impervious, but few

domestic dogs survive the bite many months. On the other hand, native dogs whose ancestors have been bred in the fly country for many generations do not succumb to the poison. The same rule applies to goats reared under similar conditions; though it would seem it must not be applied to sheep or cattle. Of all domestic animals the lowly donkey alone makes a good fight of it. As high a proportion as four donkeys out of five have spent a whole season in the fly country without signs of the poison taking effect; though donkeys will, it is believed, at times die of fly bites in the second season after being bitten. As a rule, animals bitten by flies in the dry season will live till the first rains fall, when they die within a few days. In the same way a horse if bitten will generally die within twenty-four hours of being driven through a river. . . . Like the 'horse sickness' and malarial fever, this curse to travel and transport undoubtedly recedes before the advance of civilisation, so that the far future may yet see the extinction of the Tsetse.

"Oswell reported the existence of the fly some 600 miles south of the Zambezi, when he hunted there fifty years ago. Now waggons can be taken from Bechuanaland to the Zambezi without any danger of the oxen being 'stuck.' Several flies are necessary to produce a fatal effect, but in passing through a belt in the day-time several are forthcoming. At night the danger is very small, though it is a mistake to imagine that the Tsetse keeps such early hours as other flies. I have at times been worried by them an hour after the sun has gone down, and have known flies to buzz into my tent as late as 9 o'clock on a dark night and make a bold dash for supper at my expense. At that time of night they are easily caught, and almost invariably found their way into spirits of wine.

"With all their faults, these destructive little creatures have the merit of being clean feeders. The natives, in taking an animal through a fly-belt, plaster it with cow-dung, which effectively keeps the fly at a safe distance. . . ." (pp. 61–65).

From the head-waters of the Sejlefula River to the Nanyate: Latitude of evening camp, as given on author's map, 16° 47′ 9″ S.; *approximate longitude*, 25° 48′ E.—

Tsetse-fly numerous.—"In the morning of the following day [Dec. 26, 1895] camp was struck, and I travelled through a country still pleasant, but not quite so useful-looking as that through which I had passed during the preceding few days. The Tsetse-fly became much more numerous, and the native population very sparse. In the evening, after travelling seventeen miles and crossing two Machili tributaries, I camped on a third, the Nanyate, at some distance from its source—probably ten or twelve miles" (p. 225).

Camp on rising ground in mopani swamps near the Nanzela River (an affluent of the Kafukwe); *approximate position, from the author's map,* 16° 29′ S., 26° 5 E.—"On turning out next morning [Dec. 30, 1895] a large herd of wildebeest was to be seen standing about 200 yards from the tent, gazing intently at what to them must have been quite phenomenal. . . . The Tsetse here were very troublesome, and for some little time after sunset went for us so boldly that I was able to consign many of them to my collecting-tube" (p. 228).

Tsetse-fly very troublesome on high ground to the south of the head-waters of the Nanyate: approximate position, from the author's map, 16° 57′ 1″ S., 26° 4′ E.—"The next day—the 21st of February [1896]—I camped on the highest point of the plateau traversed; my observations made it 4110 feet above the sea-level. The Tsetse-fly had been very troublesome on this high ground, which at this, the wet season, is as a rule teeming with game; but so deadly had the rinderpest proved itself that only once had game been seen since leaving Bisi. Deprived of the blood of beasts, they collected themselves and attacked the boys and myself to some tune" (p. 326).

153. 1898. **Captain the Hon. Arthur Lawley.**

"From Buluwayo to the Victoria Falls" (*Blackwood's Magazine*, Dec. 1898, p. 748).

"Before the rinderpest, this neighbourhood [the banks of the Deka, an affluent of the Zambesi] was wonderfully rich in all sorts of game, which seemed to have suffered more here from the plague than in any other part of Matabele-land. The buffalo has entirely disappeared, the koodoo (formerly very plentiful) are almost extinct, and

the other varieties have suffered severely, especially the wild pig.

"I afterwards learnt from the Barotse that before the Basuto invasion this district was thickly inhabited and rich in cattle. The Tsetse-fly was not then known between Deka and Gwaai to the east and Deka and the Zambesi to the north. After their invasion the natives were either killed by alternate raids from the Barotse and Matabele, or else they moved elsewhere, taking their cattle with them. Then the game returned, and with the game came the Tsetse-fly. Two years ago, the fly were very numerous, and the country east of the Pandamatenka road was on this account impassable for cattle and mules. Now that the game has been almost exterminated by rinderpest, the fly also has left the country, excepting a few belts of thick bush, and apparently it is gradually disappearing. All of which goes, in my opinion, to prove that the Tsetse-fly moves with the big game of the country, and that, with the latter, it is bound to disappear before the advance of civilisation."

154. 1898. **W. W. A. Fitzgerald.**

"Travels in the Coastlands of British East Africa and the Islands of Zanzibar and Pemba" (London: Chapman & Hall, Ltd.), pp. 355–357, 358, 419, 432, 434.

"One impediment to the future agricultural development of this part of the country (existing in East Africa, however, to a much less extent than in any other part of the Continent) is the presence of the *Tsetse-fly*. A variety of it, and another species, a gad-fly, are found in Witu. In the lower coast region, between Mombasa and Uganda, the Tsetse-fly is said to be localised in a comparatively narrow belt, easily passed during the night, and there is no doubt that the destruction of cattle and game during the epidemic considerably lessened the numbers of this insect pest. In Witu, too, the variety known there appears to be confined to a very limited area, chiefly forest, and in which Utwani is included. The Wa-Galla are accustomed to guard against the fly (called locally "Ganda"), when driving their cattle through the forest, by doing so at night, and by lighting large fires, the smoke of which acts as a protection to the cattle" (p. 355, *et seq.*).

[A fairly good enlarged figure of *Glossina morsitans* (more probably *Gl. pallidipes*) is given on p. 356, and a figure of the antenna (called by mistake the *proboscis*) on p. 357.]

"*Ganda*"*-fly reported to exist from Wange* (*near Lamu*) *up to Itembe*, in consequence of which neither cattle nor donkeys thrive (p. 419).

People of *Simambaya Sendeni* (a large village about three miles beyond Vundene) possess "neither cattle nor donkeys, owing to the prevalence of the Ganda-fly" (p. 432).

"The Ganda-fly is prevalent here also [*in the neighbourhood of Rubu*, a large village on the sea-coast, with the island of Simambaya lying opposite to it], consequently the people possess no cattle, but there appeared to be numbers of sheep and goats" (pp. 434–435).

[*Wange* is at the west end of the Mongoni Channel, which runs inland from Manda Bay, to the north of Manda and Lamu Is. *Itembe* is close to the coast, north-east of Patta I. *Vundene* and *Rubu* are close to the coast, five to eight miles east of Itembe.]

155. 1898. ——

"Report on the Progress of the Mombasa-Victoria (Uganda) Railway, 1897–98." Presented to both Houses of Parliament by command of Her Majesty, July, 1898. London: Printed for Her Majesty's Stationery Office by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty.

"The country in parts being infested with Tsetse-fly as far as mile 220 [a little beyond Kiboko], the mortality amongst transport animals would have been very heavy had larger transport arrangements been made for expediting works far ahead of the rails, and an enormous outlay would have been entailed which circumstances hardly seemed to justify" (p. 3).

"*Transport.*—It has been found necessary to keep up a transport department for the purpose of supplying the advanced earthwork and survey parties with food and water. Camels, donkeys, bullocks, and mules have been tried, but mules alone have been found effective, owing to the ravages caused by the Tsetse-fly amongst the other

classes of animals. It has been found that by taking special precautions and making applications of sheep-dip the mortality was to a certain extent reduced, and in the cases of mules it was only 10 per cent. during the last six months of the year" (p. 3).

With reference to the above, and especially the statement in the first-quoted paragraph as to "the country in parts being infested with Tsetse-fly as far as mile 220," the following extract from p. 2 of the *Report* will be of interest as describing the country referred to:—

"Of the entire length (263 miles) of line surveyed, it may be said that, at least, 200 are through difficult country. Except for small rivers met with at long intervals, the country is waterless and covered with dense impenetrable thorny scrub, while the surface is much broken and intersected with ravines.

"This belt of country, extending inland 200 miles, is, therefore, one through which survey operations could only be carried out under circumstances of considerable difficulty and hardship. Beyond the belt the country is more open.

"Mr. Hodson, attached to the Indian Public Works Department, who made an inspection of the railway as far as mile 100, states in his report as follows: 'The country it traverses is almost continuous thorny jungle with but few inhabitants and no cultivation, much of it practically waterless; the jungle is thorny scrub, high enough and thick enough to make surveying, and even exploring, off the regular track of the caravans, a very arduous undertaking, but devoid of all trees with foliage sufficient to give any appreciable shade.'"

156. 1898. G. de N. Hough.

Proceedings of the Academy of Natural Sciences of Philadelphia, 1898, p. 172.

Two females of *Glossina longipennis*, Corti, collected in Somali Land by Dr. A. Donaldson Smith, August 19 and 24, 1894.

157. 1898. ———

"The Secret of the Tsetse" (*The Globe*, July 11, 1898).

"A mysterious illness which has played havoc with

the mounts and transport animals of the Royal Niger Constabulary at the Lokoja headquarters has now been identified as the baneful work of the Tsetse-fly."

"· · · the Lokoja natives, knowing nothing of microbes and bacteria, assert that the fly extracts from a certain small red monkey the virus with which it inoculates the bush cow or dwarf buffalo."

158. 1899. D. Sharp.

The Cambridge Natural History. "INSECTS," Part II. (London: Macmillan & Co., Limited), pp. 512–513.

Notes on *Glossina morsitans*, with woodcuts of perfect insect, larva, and pupa (the two latter after Bruce).

"Although it has been supposed that the Tse-tse-fly is a formidable obstacle to the occupation of Africa by civilised men, there is reason to suppose that this will not ultimately prove to be the case. It only produces disease when this pre-exists in animals in the neighbourhood; only certain species are liable to it; and there is some evidence to the effect that even these may in the course of a succession of generations become capable of resisting the disease inoculated by the fly. As long ago as 1878, Dr. Drysdale [*vide supra*, **58**] suggested that this fly only produces disease by inoculating a blood-parasite, and all the evidence that has since been received tends to show that his idea is correct" (p. 513).

159. 1899. F. V. Kirby.

"SPORT IN EAST CENTRAL AFRICA, Being an Account of Hunting Trips in Portuguese and other Districts of East Central Africa" (London: Rowland Ward, Ltd.), p. 17.

On the right bank of the Inkambedsi River, near Chinde (1894).—"The heat was stifling and oppressive in the dense acacia thickets, where all the trees wore the apparel of approaching summer; and also in the bushy hollows between the rough and stony ridges, where, to add to our discomforts, Tsetse-flies swarmed in such numbers that we had to use small branches to keep them off" (p. 17).

160. 1899. Sir H. H. Johnston, K.C.B.

"A HISTORY OF THE COLONIZATION OF AFRICA BY ALIEN RACES" (Cambridge: The University Press).

The Arabs at Sena accused of having poisoned the horses and camels of Captain-General Francisco Barreto's expedition from Quelimane to Sena in 1569. "What really took place, however, seems to have been that the horses and camels were exposed to the bite of the Tsetse-fly, and died in consequence of the attacks of this venomous insect" (p. 48).

161. 1899. William Harvey Brown.

"On the South African Frontier. The Adventures and Observations of an American in Mashonaland and Matabeleland" (London: Sampson Low, Marston & Co.), pp. 151, 314–315.

Tsetse-fly numerous in the Concession Hill district, west of Hartley Hill, Mashonaland, Jan. 1, 1891.

"The sky was overcast with heavy clouds; the atmosphere was damp, and the day warm. . . . Much of the country through which we travelled was covered with enormous ant-heaps and thick jungle.

"In some places the Tsetse-flies were exceedingly troublesome, even biting through our clothing" (p. 151).

"In addition to pleuro-pneumonia among cattle, and horse-sickness among horses, there is in Rhodesia that worst of all scourges to stock, the Tsetse-fly. This is a great drawback to the importation of machinery to many of the mining districts, which lie in the fly-infested sections. Traction-engines and railways will be necessary to overcome the obstacles created by this insect pest. Fortunately, the Tsetse-fly does not occur on the plateau. It is met with mainly in the low-lying country bordering the Zambesi River. This insect is somewhat similar in appearance to a house-fly, but about three times as large. Its bite is fatal to all domestic animals, but it does not seem to affect wild game or man. When badly bitten, horses and cattle usually succumb in two or three weeks. Donkeys last longer. Few animals, however, ever recover from its bite. Until recently the supposition has been entertained that a direct poison is introduced into the system by the bite of the fly. Surgeon-Major David Bruce, of the British Army, after a long series of experiments in Zululand, has advanced the theory that 'the Tsetse acts as a carrier of a living virus, an infinitely

small parasite, from one animal to another, which enters the blood-stream of the animal bitten or pricked, there propagates, and thus gives rise to the disease.' This theory is more in harmony with modern science" (pp. 314–315).

162. 1899. **E. E. Austen.**

"REPORT OF THE PROCEEDINGS OF THE EXPEDITION FOR THE STUDY OF THE CAUSES OF MALARIA, despatched to Sierra Leone, West Africa, under the leadership of Major Ronald Ross (late Indian Medical Service), by the Liverpool School of Tropical Diseases, July 29th, 1899." Printed by Order of the Trustees of the British Museum. (London: Printed for Her Majesty's Stationery Office by Darling & Son, Ltd., 1–3, Great St. Thomas Apostle, E.C.). Pp. 18–19.

Notes on "*Glossina longipalpis*, Wied." (really *Gl. palpalis*, Rob.-Desv.), in the vicinity of Free Town, Sierra Leone.

163. 1900. **C. V. A. Peel.**

"SOMALILAND" (London: F. E. Robinson & Co.), pp. 116–117:—see also map at end of volume.

Tsetse-fly to the north of Mount Kuldush, between Bun Feroli and Biermuddo, east of the Daghato River, a tributary of the Webbi Shebeyli.

"At night, when the camels came in, they were followed by a perfect swarm of Tsetse-fly. The sting of this fly, though harmless to human beings, is very painful, and made me jump every time I was bitten, as if a needle had been stuck half an inch into my flesh. One of my ponies was badly bitten on the 'billy,' his tail not being long enough to whisk the pests off. The Somalis said the pony would live until the next rain. We rubbed sheep's fat on the ponies and the camels every day.

"It is an extraordinary sensation, coming into a belt of 'fly.' There may be but a tiny river-bed. On one side of it not a fly will be encountered, but walk a dozen feet and they suddenly come buzzing by one in hundreds.' [The year referred to is 1895.]

164. 1900. **E. E. Austen.**

Proceedings of the Zoological Society of London for the Year 1900, p. 10.

A female of *Glossina longipennis*, Corti, taken in West Somali Land, between June 23 and 25, 1895, by Mr. C. V. A. Peel.

"Mr. Peel's note on this specimen says:—'Fly-belt sharply defined from Biermuddo to Boholo Deno'" [*vide supra*, 163].

165. 1900. H. A. Bryden.

"ANIMALS OF AFRICA" (London: Sands & Co.), pp. 228–230.

A line of coaches, established some years ago to run from the Pungwe River towards Mashonaland, abandoned owing to the Tsetse-fly.—"It is a rather curious fact that wherever the African buffalo is plentiful, there you will almost certainly find the Tse-tse-fly. As the buffaloes are killed out or driven away the Tse-tse disappears, and horses and oxen can be introduced. It is supposed by many that the Tse-tse is bred in the dung of the wild buffalo, which would, of course, account for its presence in districts where buffaloes are abundant. This is a very troublesome and a very costly insect for African explorers, hunters, and settlers. Many thousands of pounds must have been lost by its ravages, and vast districts remain unopened owing to the presence of this dangerous pest. Some few years since, when Rhodesia was first being opened up, an attempt was made to run a line of coaches from the Pungwe River, on the East Coast, towards Mashonaland. Splendid American coaches were imported and plenty of fine horses and mules got out. But the Tse-tse-fly beat this spirited enterprise. The horses and mules died, the attempt had to be abandoned, and the coaches still lie rotting in the wilderness. In its turn, however, I am glad to say, the deadly Tse-tse has been overcome by the railway" (pp. 229–230).

166. 1901. Sir H. H. Johnston, K.C.B.

"REPORT BY HIS MAJESTY'S SPECIAL COMMISSIONER ON THE PROTECTORATE OF UGANDA." With Map. Presented to both Houses of Parliament by command of His Majesty. July, 1901. London: Printed for His Majesty's Stationery Office by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her late Majesty.

"The journey from Mombasa on the east coast to the

administrative centre of Uganda occupied [in 1894] under favourable circumstances from three to four months, and had to be performed mainly on foot owing to the difficulty of conveying riding animals through the belt of country near the coast infested with the Tsetse-fly" (p. 3).

167. 1901. Dr. Max Schoeller.

"MITTEILUNGEN ÜBER MEINE REISE NACH ÄQUATORIAL-OST-AFRIKA UND UGANDA, 1896–1897," Band I. (Verlag von Dietrich Reimer (Ernst Vohsen), Berlin, 1901), pp. 118–120.

In spite of careful search no Tsetse-fly was found: the deaths of the author's baggage-donkeys were apparently due to a disease allied to the horse-sickness of South Africa ("Dikkopziekte" of the Boers).

The author, writing of an attempt, which was being made by a Berlin society at the period to which this work refers, to catch zebras, and cross them with horses and donkeys, at Mbuguni, between Mt. Meru and Kilima Njaro, says :—

[Translation.] "Zebra teams would certainly have had a great advantage over all other material which comes into consideration for East Africa, in the first place because the Tsetse-fly would probably here be powerless, while horse and donkey succumb to it. Whether, however, the horse-sickness, that causes such great devastation in South Africa, will keep aloof from the zebra, or zebra-hybrids as the case may be, remains an open question, though I believe indeed that it will do so. According to the observations that we had the opportunity of making in connection with the successive deaths of our donkeys, we might almost believe that the disease called Dikkopziekte (thick-head sickness) by the Boers likewise occurs in the steppe regions of East Africa. The donkeys that we lost in the Natron Valley, and also later, all exhibited those symptoms which are mentioned as characteristic of thick-head sickness. The animals died either in the course of a few hours, or else, as was usually the case, in that of several days. Our Wadschagga believed the sickness to be the consequence of the bite of an insect (*die Folge eines Insektenstiches*); they even designated the producer by the name Wandorobo. We have searched in vain for such an insect in the places where the disease

occurred. In vain have we also looked for the puncture of the insect on the genitals of the donkeys, in which region according to the declarations of the natives it ought to be found; all that we are able to see, and this invariably, was a sometimes slower, sometimes quicker swelling-up of the mucous membranes, of the upper orbits, lips, nostrils, and jaws accompanied by greater swelling of the genitalia. The animals finally had a very high body temperature, with quickened breathing, and died of suffocation owing to difficulties in respiration. At that time we also were of the opinion that we had only lost our donkeys in the territories of the Tsetse-fly, and that the latter had occasioned the phenomena of poisoning. To-day, on the contrary, we would incline to the view, that we are confronted with a phenomenon analogous to what is found in the case of horse-sickness in South Africa, and that the sickness represents a special form of infection with the greater probability, since the South African disease already appears to be recognised as such. Definite grounds for believing in insects (*bestimmte Anhaltspunkte für Insekten*) have not been discovered, and the imported Muscat donkeys were attacked soonest and in the largest percentage. According to the statement of the natives, moreover, similar symptoms of disease sometimes appear in human beings. At the coast it had already been prophesied that we should lose our donkeys on the steppe, and we therefore searched for the Tsetse-fly so zealously, that it would scarcely have escaped us if we had really entered its territory. That the Wadschagga designate a small fly by the name Wandorobo appears to me to be probable, but the question is whether we are here dealing with the Tsetse-fly. The districts in which we lost our baggage-donkeys cannot be called free from fever; the Natron Valley, where the sickness first appeared, is in many places swampy, and the neighbourhood of Kibwesi, which is characterised as especially unfavourable for the escape of the animals, would doubtless exhibit malaria. As Professor Koch has shown, punctures by insects have an importance in connection with malarial infection in so far as blood-sucking insects carry contagious matter into the blood. It may well be doubted whether it is the Wandorobo-fly alone that is able to transport the malaria

poison to certain animals, or to inoculate the horse-sickness that is caused by plasmodia—rather may the most widely different biting-flies, midges, etc., provide for an occasional transference of fever bacteria. Just as the latter under definite conditions of life develop into definite forms, so also will the poison occasion special sickness symptoms in the case of the different animals. In South Africa it is supposed that the donkey and the Quagga [*sic*] escape the horse-sickness, but that observation in no way guarantees that the same is also the case in East Africa. It is also not impossible in the case of other forms of bacteria, that at certain times, in certain districts, and under all kinds of apparently unimportant collateral circumstances, they fall into a condition of harmless sterility, to attack their victim later on or elsewhere under more favourable conditions with devastating vehemence."

168. 1901. Sir C. N. E. Eliot, K.C.M.G.

"Report by His Majesty's Commissioner on the East Africa Protectorate (Africa, No. 9 (1901))." Presented to both Houses of Parliament by command of His Majesty. August, 1901. London: Printed for His Majesty's Stationery Office, by Harrison & Sons, St. Martin's Lane, Printers in Ordinary to His Majesty.

"Horses and mules are now used for travelling purposes in Ukamba, and it is no longer the custom to make long marches on foot. This is one of the many advantageous changes wrought by the [Uganda] railway. Horses do not thrive in the coast districts, and it was formerly impossible to take them up-country through regions where they were exposed to Tsetse-fly and various sicknesses. Now they can be transported rapidly through the dangerous zone to the interior" (p. 20).

"I have hoped that in course of time some practical steps may be taken towards domesticating the zebra and the wildebeeste. These animals appear to be immune to the deadly Tsetse-fly which abounds in some districts of the Protectorate, and, if either of them or mules bred from them could be employed as pack or draught animals, it would in all probability have an incalculably good effect upon the country, the prosperity of which is at present sadly hampered by want of efficient transport." (p. 25).

169. 1901. S. L. Hinde and H. Hinde.

"The Last of the Masai" (London: William Heinemann), p. 167.

Field Notes on the Game of East Africa (*i.e.* The British East Africa Protectorate).—"Owing to the difficulty of getting horses through the Tsetse-fly belt, which extends over 200 miles from the sea-coast, all hunting and shooting has until now been done on foot. Since the advent of the railway it is feared that luxurious 'sportsmen' will bring their horses with them, and another factor will be brought to bear upon the final extinction of big game in the last stronghold left in Africa."

170. 1901. Dr. Schilling.

"Bericht über die Surra-Krankheit der Pferde" (*Centralblatt für Bakteriologie, Parasitenkunde und Infektions-Krankheiten.* Erste Abteilung: Medicinisch-hygienische Bakteriologie und tierische Parasitenkunde. xxx. Band. No. 15. Jena, 30 Oct. 1901, pp. 545–551).

The author, who writes from Kleinpopo, Togo, gives an account of a disease which is fatal to horses in Togo, Slave Coast, W. Africa. He calls the disease Surra, and describes the Trypanosome which causes it.

Tsetse-fly in the Togo Protectorate.—[Translation.] "The Tsetse-fly is accused of being the carrier of Surra. So far as I am aware, this fly does not occur in the Togo Protectorate littoral, which lies between sea and lagoon. On the other shore of the lagoon, consequently at a distance of some three kilometres from the sea-coast, it is very common. The natives know the fly by the name "adjoë." Experiments intended to elucidate the rôle of the Tsetse-fly in infecting animals with the disease are only in the initial stage, since hitherto a sufficient supply of flies has been wanting. At any rate, the fly bites very readily, and sucks up large quantities of blood with its extremely fine, tubular proboscis. In the case of dogs and horses no perceptible swelling appears after the bite, and therefore it seems to be questionable whether a "saliva," as in the mosquito, is produced at all. The dissection of the insects is very difficult, owing to the great development of the musculature and the firmness of the tracheal network" (p. 551).

171. 1902. A. Laveran et F. Mesnil.

"Recherches morphologiques et expérimentales sur le Trypanosome du Nagana ou Maladie de la Mouche Tsétsé (*Annales de L'Institut Pasteur*, Jan. 25, 1902, pp. 1–55).

Three figures of *Glossina* (probably *Gl. pallidipes*, Austen) on p. 8 (after Bruce).

According to the authors, the Tsetse-fly occurs in the *vicinity of Lake Tchad:* in an enumeration on p. 2 of the localities in which Tsetse-fly disease is known to exist, they state that it is particularly prevalent in the region of Lake Tchad, on the banks of the Chari and its affluents; adding in a foot-note that the statement is based upon information supplied by Inspector-General Kermorgant, who received it from Surgeon-Major Morel, of the French Colonial Army. Specimens of the Tsetse-fly were enclosed in General Kermorgant's letter.

It is stated on the authority of Blanchard (*Bulletin de l'Académie de médecine*, 3e série, xlvi, 29 Oct. 1901), who quotes a writer named Brumpt, that at Imi, on the Webi Shebeli, Somaliland, all the camels of a mission, as well as the mules and donkeys, succumbed to a Trypanosoma. The epizooty observed by Brumpt did not appear to be propagated by the ordinary Tsetse-fly, but by a closely allied species of *Glossina* [doubtless *Gl. longipennis*, Corti].

During the Abyssinian campaign of 1867 there was great mortality among the transport animals, and a veterinary surgeon named Hallen,* proceeding from Abyssinia to India, was struck by the resemblance between Surra and the Abyssinian disease.

172. 1902. Sir Harry Johnston, G.C.M.G., K.C.B.

"The Uganda Protectorate" (London: Hutchinson & Co.), Vol. I.

"Either there is no true Tsetse-fly in the Uganda Protectorate or it is not able to obtain and introduce into the bodies of domestic animals the malarial germs which cause Tsetse fever. Therefore, theoretically there is no part of the Uganda Protectorate in which cattle, sheep, goats, and horses cannot be kept" (pp. 288–289).

* The late Lieut.-Colonel J. H. B. Hallen, A.V.D., who accompanied Lord Napier's expeditionary force to Magdala, and was afterwards for some time Chief of the Veterinary School at Bombay.

"Flies of the genus *Glossina* (a genus of which the Tse-tse is a member) exist in the Uganda Protectorate. They have been caught there by Mr. Jackson and myself, not to mention many other collectors. But either the true Tse-tse is absent from all parts of the Protectorate or it is unable to obtain there the germs of fever which it is the agent in introducing to the blood of horses, cattle, and other beasts. This is a very fortunate circumstance, as it removes a serious hindrance in the way of rearing live-stock and developing transport" (pp. 413–414).

173. 1902. J. N. Justice.

"PROSPECTING IN NORTHERN RHODESIA" (*Travel*, Vol. VII., July, 1902. London: Horace Marshall & Son, p. 102).

Tsetse-fly near the Kafue River, 1900.—*Natives state that the virulence of the bite of the fly has greatly diminished since the extermination of the buffalo by rinderpest.*

"It was not far from here [near the Kafue River, about ninety miles above its confluence with the Zambesi] that we sustained our first losses from the Tsetse-fly; sixteen donkeys and two horses fell victims to this scourge of the country in the nine months of the expedition. Livingstone thought that donkeys were immune from the evil effects of the fly's bite, but this has long since been disproved; the natives, however, state that since the rinderpest exterminated the buffalo the tsetse has lost much of its venom, and it does indeed seem to be less virulent than formerly, as a horse lives now for three weeks after a bite, whereas in former times it died a few days afterwards."

174. 1902. Dr. Franz Stuhlmann.

"VORKOMMEN VON GLOSSINA TABANIFORMIS (WESTW.) BEI DAR-ES-SALÂM" (*Berichte über Land- und Forstwirtschaft in Deutsch-Ostafrika.* Herausgegeben vom Kaiserlichen Gouvernement von Deutsch-Ostafrika, Dar-es-Salâm. 1 Bd. Heft 2, pp. 173–175, with figure of the antenna, magnified thirty-eight times, in text. Heidelberg, June, 1902: Carl Winter's Universitätsbuchhandlung).

A few specimens of a biting fly, which, on examination, proved to be "*Glossina tabaniformis*, Westw.," (*Gl.*

fusca, Walk.), "were caught in January, 1902, at Mangamara, a little way to the north of Dar-es Salâm, beyond Msimbasi Creek."

The following is a translation of the concluding paragraph of this paper (p. 175).

"Now the most interesting question is whether this species of *Glossina* also conveys Surra-disease. Reasoning from general conclusions derived from analogy in connection with the diseases due to infection of the blood, in which each parasite has its own particular host and intermediate host, I should be inclined *a priori* to answer this question in the negative. This biting fly is evidently not rare near Dar-es-Salâm, and no case of Surrahas yet been observed originating from there. At the place where the flies were caught the same cattle and goats have grazed for a long time, without disease appearing among them. The examination of the blood of the goats has so far not revealed any Trypanosomes, but this examination must be continued and extended to cattle and donkeys. I think, however, it may be assumed that Surra-disease is not conveyed by *Glossina tabaniformis*."

BIBLIOGRAPHY.—PART II.

TSETSE-FLY DISEASE AND THE *TRYPANOSOMA* OF NAGANA AND KINDRED SPECIES.

I. 1897. Surgeon-Major David Bruce, A.M.S. (now Lieut.-Col. David Bruce, R.A.M.C.).

"Further Report on the Tsetse-Fly Disease or Nagana in Zululand." Ubombo, Zululand, 29th May, 1896 (London: Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty, 4th February, 1897), 69 pp., Plates I–VI.

[See Chapter VII., Appendix A.]

II. 1898. G. H. F. Nuttall.

"Neuere Untersuchungen über Malaria, Texas-fieber und Tsetsefliegenkrankheit" (*Hygienische Rundschau*, Berlin, 15th Nov., 1898, VIII, pp. 1084–1103).

III. 1898. R. Koch.

"Reiseberichte über Rinderpest, Bubonenpest in Indien und Afrika, Tsetse- oder Surrakrankheit, Texas Fieber, tropische Malaria, Schwarzwasserfieber" (Berlin: J. Springer: 136 pp.). Pp. 65–72, 87–88.

According to Laveran and Mesnil, [171] p. 2, notes 1 and 2, the author records the occurrence of Nagana in German East Africa, and states (p. 66) that in 1895 he observed Trypanosomes in blood-films relating to Tsetse-fly disease, which had been forwarded to him from Togo (Slave Coast).

IV. 1898. Dr. G. Nepveu.

"Sur un Trypanosome dans le sang de l'homme" (*Comptes Rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie.* Tome cinquième—Dixième Série. Séance du 24 Décembre 1898, pp. 1172–1174).

The parasite was found in 1890 fairly common in the blood of a patient in Algeria, together with *Laverania.* It is not described in detail or named, but exhibited all the characters of *Trypanosoma.* The organism was first mentioned by the author in his paper entitled "*Étude sur les Parasites du Sang chez les Paludiques*" (Compt. Rend. Hebd. des Séances et Mém. Soc. Biol. Tome Troisième—Neuvième Série. Année 1891, pp. 39–50).

V. 1898. A. A. Kanthack, H. E. Durham, and W. F. H. Blandford.

"On Nagana, or Tsetse-Fly Disease." Report, made to the Tsetse-fly Committee of the Royal Society, of Observations and Experiments carried out from November, 1896, to August, 1898 (*Proceedings of the Royal Society of London*, Vol. LXIV., Nov. 19, 1898, pp. 100–118).

VI. 1899. G. H. F. Nuttall, M.D.

"On the Rôle of Insects, Arachnids and Myriapods, as carriers in the Spread of Bacterial and Parasitic Diseases of Man and Animals. A Critical and Historical Study (*Johns Hopkins Hospital Reports*, Vol. VIII., pp. 1–155, Plates I.–III.).

Tsetse-fly Disease, pp. 68–71.—Résumé, chiefly of Bruce's results.

Bibliography, pp. 139–140.

VII. 1899. H. G. Plimmer and J. Rose Bradford.

"A Preliminary Note on the Morphology and Distribution of the Organism found in the Tsetse-fly Disease" (*Proceedings of the Royal Society of London*, Vol. LXV., Aug. 31, 1899, pp. 274–281).

VIII. 1900. A. Laveran et F. Mesnil.

"De la Longue Conservation à la Glacière des Trypanosomes du Rat et de l'Agglomération de ces Parasites" (*Comptes Rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie.* Séance du 6 Octobre 1900, pp. 816–819).

IX. 1900. A. Laveran et F. Mesnil.

"Sur l'Agglutination des Trypanosomes du Rat par divers Sérums" (*Comptes Rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie.* Séance du 10 Novembre, pp. 939–942).

X. 1900. A. Laveran et F. Mesnil.

"Sur le mode de multiplication du Trypanosome du Rat" (*Comptes Rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie.* Séance du 17 Novembre, 1900, pp. 976–980. With figures in text.)

XI. 1901. A. Laveran et F. Mesnil.

"Sur le mode de Multiplication du Trypanosome du Nagana" (*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie.* Tome LIII. Séance du 23 Mars 1901, pp. 326–329).

[With five figures showing the multiplication of the Trypanosome by longitudinal division.]

XII. 1901. A. Laveran et F. Mesnil.

"Sur la Nature Centrosomique du Corpuscule Chromatique Postérieur des Trypanosomes" (*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie.* Tome LIII. Séance du 23 Mars 1901, pp. 329–331).

XIII. 1901. E. Nocard.

"Sur les Rapports qui existent entre la *Dourine* et le *Surra* ou le *Nagana*" (*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie.* Tome LIII. Séance du 4 Mai 1901, pp. 464–466).

XIV. 1901. A. Laveran et F. Mesnil.

"Sur la structure du Trypanosome des grenouilles et sur l'extension du genre *Trypanosoma*, Gruby" (*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie.* Tome LIII. Séance du 22 Juin 1901, pp. 678–680 (with figures in text)).

The following is a translation of the final paragraph of this paper :—"In conclusion, our observations show that the Trypanosome of the green frog exhibits all the peculiarities regarded by Wasielewsky and Senn as characteristic of the genus *Herpetomonas*. Under these conditions this genus must disappear, and the generic name *Trypanosoma* alone will serve to designate all the flagellated parasites in the blood of Vertebrates, at least all those at present known."

XIVa. 1901. A. Laveran et F. Mesnil.

"Sur la Morphologie et la systématique des Flagellés à membrane ondulante (genres *Trypanosoma* Gruby et *Trichomonas* Donné)" (*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Tome CXXXIII., No. 3 (15 Juillet 1901), pp. 131–137, with five figures in text).

XV. 1901. A. Laveran et F. Mesnil.

"Sur la Nature Bactérienne du Prétendu Trypanosome des Huîtres (*Tryp. Balbiani*, Certes)" (*Comptes Rendus Hebdomadaires des Séances de la Société de Biologie.* Tome LIII. Séance du 19 Octobre, pp. 883–885).

XVa. 1901. A. Laveran et F. Mesnil.

"Sur les Flagellés à membrane ondulante des Poissons (genres *Trypanosoma* Gruby et *Trypanoplasma* n. gen.)" (*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Tome CXXXIII., No. 18 (28 Octobre 1901), pp. 670–675, with four figures in text).

XVI. 1901. A. Laveran et F. Mesnil.

"Sur le Trypanosome des Rats" (*T. lewisi*, Kent) (*Annales de l'Institut Pasteur*, September 25, 1901, pp. 679–684).

XVII. 1901. Dr. Schilling.

"Bericht über die Surra-Krankheit der Pferde" (*Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten.* Erste Abteilung: Medicinish-hygienische Bakteriologie und tierische Parasitenkunde. XXX. Band. No. 15. Jena, 30 Oct. 1901, pp. 545–551).

The author, who writes from Kleinpopo, Togo, gives an account of a disease which is fatal to horses in the Togo Protectorate, Slave Coast, W. Africa. He calls the disease Surra, and describes the Trypanosome which causes it.

XVIII. 1901. A. Theiler.

"Die Tsetse-Krankheit" (*Schweizer Archiv für Thierheilkunde*, XLIII. Band, p. 97).

XIX. 1901. L. Rogers, M.D.

"The Transmission of the *Trypanosoma Evansi* by Horse Flies, and other Experiments pointing to the Probable Identity of Surra of India and Nagana or Tsetse-fly Disease of Africa (*Proceedings of the Royal Society of London*, Vol. LXVIII., pp. 163–170).

"The close resemblance between Surra of India and Tsetse-fly disease of Africa has long been known, while Koch, after having seen the living *Trypanosoma Evansi* at Muktesar in India, and soon after studied the parallel disease in German East Africa, pronounces them to be the same, and in his 'Reiseberichte' calls the disease seen in the latter place 'Surrakrankheit' (p. 163).

"In every case in which the flies had been kept from one to four or more days after biting the infected animals, no disease ensued in the healthy ones. Many such flies were dissected and microscopically examined, but in no case was anything which might be taken for a development of the Trypanosoma in the tissues of the insect detected. . . . When, however, flies which had just sucked infected blood were immediately allowed to bite another healthy animal, positive results were obtained after an incubation period corresponding with that of the disease produced when a minimal dose of infected blood is inoculated into an animal of the same species. The result was uncertain if only one or two flies were allowed to bite, and especially

if they were allowed to suck as much blood as they wished without being disturbed. If, on the other hand, several flies, which had just sucked an infected animal, were induced to bite a healthy one, and especially if they were disturbed and allowed to bite again several times, infection was always readily produced in both rabbits and dogs, the fur of the latter having been carefully cut, without abrading the skin, at the site over which the flies were applied" (p. 164).

"In every point, then, that I have so far investigated, the results obtained in the case of Surra closely agree with those of the Royal Society's Committee in Tsetse-fly disease, and so far as they go they support the view that the two diseases are probably identical" (p. 169).

XX. 1902. J. R. Bradford and H. G. Plimmer.

"THE TRYPANOSOMA BRUCII, THE ORGANISM FOUND IN NAGANA, OR TSE-TSE-FLY DISEASE" (*Quarterly Journal of Microscopical Science*, Vol. 45. New Series, pp. 449–471, Plates 24 and 25).

XXI. 1902. A. Laveran et F. Mesnil.

"RECHERCHES MORPHOLOGIQUES ET EXPÉRIMENTALES SUR LE TRYPANOSOME DU NAGANA OU MALADIE DE LA MOUCHE TSÉTSÉ" (*Annales de l'Institut Pasteur*, Jan. 25, 1902, pp. 1–55).

XXII. 1902. A. Laveran.

"SUR UN NOUVEAU TRYPANOSOME DES BOVIDÉS" (*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Tome CXXXIV, No. 9 (3 Mars 1902), pp. 512–514).

XIII. 1902. A. Laveran.

"DE L'ACTION DU SÉRUM HUMAIN SUR LE TRYPANOSOME DU NAGANA (*Tr. Brucei*)" (*Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences*, Tome CXXXIV, No. 13 (1er Avril 1902), pp. 735–739).

XXIV. 1902. Lieut.-Col. D. Bruce, R.A.M.C.

"NOTE ON THE DISCOVERY ON A NEW TRYPANOSOMA" (*Proceedings of the Royal Society of London*, Vol. LXIX., p. 496).

"This new species can be at once distinguished from the Trypanosomas of Surra, Tse-tse-fly disease, or Rat by

its larger size, it being almost twice as large as any of the others. In general appearance it conforms closely to the others in possessing an oval protoplasmic body, a longitudinal fin-like membrane, and a single flagellum.

"This new Trypanosoma was lately discovered by Dr. A. Theiler, who is in charge of the Bacteriological Laboratory of the Medical Officer of Health, Pretoria, Transvaal."

Dr. Theiler "found the parasite for the first time in the blood of a young ox which had just recovered from an attack of rinderpest. . . ." "He found that the new Trypanosoma only infects cattle. Horses, dogs, goats, rabbits, and guinea-pigs are all immune, neither showing symptoms nor the presence of the parasites in the blood."

XXV. 1902. J. E. Dutton, M.B.

"Preliminary Note upon a Trypanosome Occurring in the Blood of Man" (*Thompson Yates Laboratory Reports, Liverpool*, Vol. IV., Part II., pp. 455–468, Plates V., VI., Charts 1–4).

XXVI. 1902. Dr. Franz Stuhlmann.

"Notizen über die Tsetsefliege (Glossina morsitans, Westw.) und die durch sie übertragene Surrahkrankheit in Deutsch-Ostafrika" (*Berichte über Land- und Forstwirtschaft in Deutsch-Ostafrika*. Herausgegeben vom Kaiserlichen Gouvernement von Deutsch-Ostafrika, Dar-es-Salâm. 1 Bd. Heft 2, pp. 137–153, Tafel I and II, and four figures in the text. Heidelberg, June, 1902: Carl Winter's Universitätsbuchhandlung). Tafel I gives rough figures of *Glossina morsitans*, and details, and also figures of several species of *Trypanosoma*. Tafel II consists of a sketch-map of German East Africa, on which places known to be, or suspected of being, centres of "Surra," and roads on which bullock-teams have been attacked by the disease, are marked in red.

The author commences by stating that a portion of the mortality among cattle in German East Africa was determined by Koch, in 1897, to be due to Surra. He proceeds to discuss the true part played by the Tsetse-fly, and *rejects the idea that it is merely a passive carrier of the hæmatozoon*.

[Translation.] "The investigations upon Texas fever

which is carried by ticks, and especially upon the different forms of malaria lend the greatest probability to the conclusion, that each of these blood-diseases can be carried only by a perfectly definite kind of blood-sucking insect (human malaria by *Anopheles*, bird malaria by *Culex*, Texas fever by the tick, recurrent fever by bugs, and so on), and that in this intermediate host the organism that occasions the disease passes through a special stage of development, which appears generally to be a sexual reproduction.*

"Now since in South Africa experiments have furnished incontrovertible proof that the Trypanosoma-disease is carried by the Tsetse-fly, the bite of which had long been dreaded as being fatal; since on the other hand the same disease occurs here; and finally seeing that the true Tsetse-fly has been observed here, it is justifiable to conclude that it is highly probable that in our colony also Surra is carried, and, moreover, *exclusively* carried by this one fly, the Tsetse. The fact is that, in the case of all these blood diseases, the host and intermediate host are animals of perfectly definite kinds. It is, moreover, improbable that the proboscis† of the Tsetse merely operates as an inoculating-needle; rather must we assume, from analogy with malaria, that within the fly the Trypanosoma passes through a special stage of development, which it is true is at present unknown" (pp. 137–138).

Numbers of Tsetse-flies, which were identified as specimens of *Glossina morsitans*, Westw., were found on Feb. 18 and 19, 1900, on the road from Kilwa to Barikiwa: the weather at the time was thundery and rainy (p. 138).

Notes on the genus *Glossina*, and on *Stomoxys calcitrans*, with woodcuts of the latter and its transformations (after Howard) (pp. 138–141). At the bottom of p. 139 the development of the Tsetse is stated in error to be still entirely unknown. Pages 141 to 146 are devoted to a description of *Glossina morsitans*, based upon an examination of three specimens taken near Kilwa, as mentioned

* It should be noted, however, that the host in which a parasite becomes sexually mature is the *definitive* and not the intermediate one. Thus in the case of æstivo-autumnal fever *Anopheles* is the definitive and man the intermediate host of *Laverania præcox*.—E. E. A.

† The word in the original is *Stich*, meaning literally "stab" or "puncture."—E. E. A.

above. On p. 145, there is a comparative diagnosis of *Gl. morsitans*, "*tachinoides*," and "*tabaniformis*."

Notes on the distribution of "Surra" and Tsetse-flies in German East Africa.

[Translation.] "Since the labours of Professor Koch innumerable cases of Surra have been observed here, above all by Veterinary-Surgeon Schmidt; in addition to this small herds of cattle have been driven, by way of experiment, along certain roads, in order to discover by what roads cattle can be transported without danger of contracting the disease. The results are shown on the appended map (Tafel II), on which the red spots indicate the places where Surra infection has been positively demonstrated or where it is strongly suspected to exist, while the red streaks show the roads on which animals were infected. It looks quite distressing to find the very foot of the Usambara Mountains, in the neighbourhood of the coffee plantations, so thickly beset with Surra-foci, but we must consider that that was the place where many cases came under observation, and that consequently it is probable that in future many a centre of infection will also be found in the remainder of the territory. On the whole, river-lowlands with high reed-grass seem to be exceptionally dangerous, just as in South Africa the plains of the Limpopo and Zambesi are especially dreaded.

"Particularly at the foot of East Usambara have cases of infection frequently been shown to have occurred; many a head of cattle kept on the plantations, which had formerly been driven through these districts, died from Surra. The following localities are especially suspicious: Bondei Land, Kwa Maromo, the neighbourhood of Lewa, and also Mombo, Masinde, the eastern foot of the Pare Mountains and the borders of Lake Jipe. The mountains of West Usambara, the localities Korogwe and Massigi, as well as Lake Manga are certainly free from the disease. The Masai, who are well-known as the best herdsmen, always ascribe the deaths of cattle to the fact of their having eaten reed-grass; but it is to be supposed that it is precisely this grass that harbours the Tsetse-fly, which occasions the infection. The fly dreaded by the Masai under the name 'Ndorobbo' is still unknown; it appears, however, from the description to be more probably a

horse-fly. Tsetse-flies have also been observed quite close to Mombasa (Koch, *Reiseberichte*, p. 70).

"In the Hinterland of Dar-es-Salâm the low ground bordering the Gerengere River is under suspicion; Veterinary-Surgeon Schmidt himself observed the fly between Mt. Kikundi and the Uluguru Mountains (January 1901). The whole of the road as far as Mpwapwa is for the present suspected, while further on as far as Tabora it appears to be free from Tsetse-flies. On the other hand cases of infection have been observed on the Tabora-Ujiji road, probably on the upper Mlagarasi brook. The road from Iringa to Kilossa is very risky, and especially on the Great Ruaha River (called Mpagali from Tayeta to beyond the point where the Lukose debouches into it) is it impossible to keep any cattle. Similarly no cattle can be kept in Marore. The Tsetse belt begins probably at the Great Ruaha and extends as far as Kirengawana. In the same way the road from Iringa, by Dwangire-Ngahoma, to Kungulio is risky. Inland from Kilwa the Tsetse-fly has definitely been shown to occur on the Donde road between the 29th and 52nd kilometres (*Knochenhauer*), and also near Gerengere village (*Veterinary-Surgeon Schmidt*). For this reason the choice of this place as agricultural experiment station for the commune of Kilwa is not a happy one. On the road from Dar-es-Salâm to Songea two mules were attacked by Surra, as also were cattle on the journey from Songea to Lukuledi. At that time (July 1899), according to reports received from Lukuledi Mission, the Tsetse-fly was observed at the camping-places, Kokoma, Chamba, Darhammam, and Chitwanga, and especially in Chamba. In the latter place it has been experimentally proved by the Songea Station that cattle kept for only two days become infected by Surra.

"The great cattle-breeding countries of the inter-lacustrine region, Ugogo, Unyamwesi, the region devoid of watercourses, Masailand, and so forth appear to be free from Surra.

"Nevertheless, it appears from the facts ascertained up till now, that on account of the risk of infection the transporting of loads by means of draught animals is only possible in certain places in the colony, and that, there-

fore, we must begin to build railways, if we would replace the system of carrying loads on the heads of niggers" (pp. 146–147).

Discussion of the question of immunity, or "facultative' immunity to Tsetse-fly disease (p. 148). The following is a translation of the concluding sentences of this section: "It was thought, hitherto, that the gray, or so-called Masai donkey is immune; but in Mombo at the foot of the Usambara Mountains, the parasites of Surra have been detected in the blood of Masai donkeys which fell sick there. Perhaps, however, the greater number of Masai donkeys are facultatively immune. At any rate, the infection experiments of Koch had a negative result (*Reiseberichte*, p. 70). It is probable that immunity may also be produced artificially. Professor Koch and Veterinary-Surgeon Schmidt have already made a beginning here with experiments in this direction, while experiments with a serum-treatment were recently carried out by Dr. Schilling, in Togo, apparently with success. (*Sitzungsber. des kolonialwirtschaftlichen Komitees*, 1901)."

Veterinary-Surgeon Schmidt's views as to the nature of Tsetse-fly disease (pp. 148–150).

[Translation.] "Veterinary-Surgeon Schmidt has recorded his opinions on Surra in the following memorandum, addressed to the Songea Station and here reproduced verbatim:—

"'1. In a district free from Tsetse Surra cannot be conveyed from one animal to another either directly or indirectly. Flies and horse-flies other than the Tsetse are of no importance as regards the occurrence of Surra, since, analogously to all parasitic diseases, a correlation exists between host, parasite, and intermediate host, so that the disease is not developed if only a single one of the three conditions is not fulfilled.

"'(a) The parasite lives only in the blood of animals susceptible to the disease (single- and double-hoofed Ungulates),* but can be transmitted to almost all animals by artificial inoculations.

* The limitation of Tsetse-fly disease to Ungulates is not in accordance with the result of Lieut.-Col. Bruce's experiment, in which the disease was produced in a dog by inoculation with blood from a *hyæna* (see Chapter VII., Appendix A, p. 280).—E. E. A.

"'(b) The only intermediate * host is the Tsetse-fly, in which the parasite passes through a process of development which has not yet been observed.

"'(c) After attaining its full development the parasite once more enters the blood of the animals susceptible to Surra, by means of the bite of the Tsetse-fly, and after an interval of about four to six weeks produces noticeable symptoms of disease.

"'2. In inoculation experiments the interval which elapses until symptoms of the disease manifest themselves is usually from four to six weeks.

"'(a) Consequently at the same period parasites can also be demonstrated in the blood. Analogously to malaria, fresh attacks of fever always occur simultaneously with the development of a new generation of the parasites, while in the interval the temperature is normal, and it is also impossible to demonstrate the presence of the parasites by means of the microscope. It is therefore necessary to take samples of blood every three or four days, corresponding with the process of development, shortly before a fresh attack of fever supervenes.

"'The number of the parasites, the condition of the animal, and the amount of work demanded from it all affect the course of the malady. When carefully tended, animals suffering from Surra live for years, while great bodily exertion renders the course of the disease acute.

"'(b) Simultaneously with the appearance of the parasites in the blood careful observation also shows symptoms of the disease (intermittent fever, cessation of appetite, sluggishness of movements). Noticeable symptoms occur only after the disease has lasted some time, in the shape of emaciation and anæmia of the mucous membranes. The only positive proof for the expert is and remains the demonstration of the parasites in the blood. Cattle are more susceptible to Surra than mules.

"'3. It is not permissible to regard districts rich in game as being infected with Surra, since all known single- and double-hoofed Ungulates succumb to the disease; neither, for the same reason, can the occurrence of Tsetse-flies be associated with that of the buffalo.'

"According to this, Veterinary-Surgeon Schmidt

* *Cf.* p. 260, note *.—E. E. A.

appears to be of the opinion that wild animals are also susceptible to Surra." *

Notes on the habits of the Tsetse, and on the Relations between it and the TRYPANOSOMA (p. 150).

[Translation.] "So far as I am aware, not many observations upon the bionomics of the Tsetse exist. The fly appears to live in reed-beds bordering streams, and in damp bush. It flies at its victim with a buzzing noise, bites it in the flanks, on the belly, and elsewhere, and, according to an observation by Veterinary-Surgeon Schmidt, disappears again with equal rapidity. It is said not to pursue its victim. The fly bites only during the day, or, at most, on bright moonlight nights in addition. Consequently in most cases Tsetse-districts can be passed through with animals without harm in the night.

"The mode of development of the Tsetse is still, so far as I am aware, entirely unknown.† A yet richer field for research, however, is offered by the investigation of the development and life-history of the blood-parasite (*Trypanosoma*), which is the actual cause of Surra disease. Probably, just as the plasmodium of malaria does in *Anopheles*, the parasite passes through a special generation in the body of the fly. Undoubtedly, just as in the case of malaria, it is possible for one ox to be directly infected with Surra from another by means of inoculation of blood; but the normal course of development will be, as in malaria and Texas fever, that in the biting insects the Trypanosomes pass through a special developmental cycle (sexual reproduction). In malaria, according to the investigations of Ross and Grassi, the parasites (*Plasmodium*) pass into the stomach, thence into the stomach-wall, and finally into the salivary glands."

On pp. 151–152 a diagnosis of the genus *Trypanosoma* is given, derived from Bütschli's article on *Protozoa* in Bronn's "Klassen und Ordnungen des Tierreichs." On

* In other words, if Schmidt's view is correct, the parasite of Tsetse-fly disease will only exceptionally be found in the blood of an antelope, buffalo, or zebra; since its presence in the blood would entail the death of a wild animal equally with that of a domesticated one. This, however, is contrary to the experience of other observers.—E. E. A.

† Dr. Stuhlmann is evidently ignorant of Col. Bruce's discovery on this point.—E. E. A.

p. 152 the author suggests that, among others, the following points should be aimed at in future investigation of Tsetse-fly disease :—

"1. To bring together for examination specimens of biting flies from as many different points as possible.

"2. To observe the habits and life-history of the Tsetse.

"3. To find out the places in which, according to the experience of the natives, cattle can never be kept.

"4. To make a careful examination of the blood of many diseased animals, especially in cases in which it is possible to state definitely where the infection took place.

"5. To ascertain whether, in the case of the different kinds of animals, the disease is conveyed by one and the same species of biting fly.

"6. To investigate the fate of the Trypanosomes in the Tsetse, and the manner in which they pass from it into the mammal (salivary glands?)

"7. To investigate the susceptibility of big game, facultative immunity, especially in young animals, and artificial immunity owing to treatment with serum."

XXVII. 1902. Dr. Schilling.

"Bericht über die Surra-Krankheit der Pferde und Rinder im Schutzgebiet Togo" (*Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten.* Erste Abteilung: Medicinish-hygienische Bakteriologie und tierische Parasitenkunde. XXXI. Band. No. 10).

XXVIII. 1902. Dr. Hans Ziemann.

"Tse-tse-Krankheit in Togo (West Afrika)" (*Berliner klinische Wochenschrift*, 1902, No. 40. *Separate pagination* pp. 1–18).—Translated by P. Falcke, in "*The Journal of Tropical Medicine*," Vol. V., No. 23, Dec. 1, 1902, p. 367, *et seq.*

XXIX. 1902. R. M. Forde, L.R.C.S., &c.

"Some Clinical Notes on a European Patient in whose Blood a Trypanosoma was Observed" (*The Journal of Tropical Medicine*, No. 17, Vol. V., September 1, 1902, pp. 261–263 : with temperature charts, and a plate showing the parasite in a stained preparation of blood).

XXX. 1902. R. Boyce, M.B., F.R.S. ; Ronald Ross, C.B., F.R.S., F.R.C.S. ; C. S. Sherrington, M.D., F.R.S.

"NOTE ON THE DISCOVERY OF THE HUMAN TRYPANOSOME" (*The British Medical Journal* and *The Lancet*, Nov. 22, 1902).

XXXI. 1902. R. M. Forde.

"THE DISCOVERY OF THE HUMAN TRYPANOSOMA" (*The British Medical Journal*, Nov. 29, 1902).

XXXII. 1902. L. W. Sambon, M.D.

"NOTE ON THE DISCOVERY OF THE HUMAN TRYPANOSOME" (*The Lancet*, Dec., 5, 1902).

XXXIII. 1902. A. Laveran.

"RECHERCHES SUR LE TRAITEMENT ET LA PRÉVENTION DU NAGANA" (*Annales de l'Institut*, Tome XVI., No. 11 (25 Nov. 1902), pp. 785–818).

XXXIV. 1903. Dr. Schilling.

"ON NAGANA AND OTHER TRYPANOSOMES" (*The Journal of Tropical Medicine*, No. 3, Vol. VI., February 2, 1903, pp. 45–47).

CHAPTER VII.

APPENDICES.

APPENDIX A.

ABSTRACT OF LIEUT.-COLONEL BRUCE'S "FURTHER REPORT ON THE TSETSE-FLY DISEASE" ("FURTHER REPORT ON THE TSETSE-FLY DISEASE OR NAGANA IN ZULULAND. By Surgeon-Major DAVID BRUCE, A.M.S.—Ubombo, Zululand, 29th May, 1896.") (London: Harrison & Sons, St. Martin's Lane, Printers in Ordinary to Her Majesty. 4th February, 1897. 69 pp., sm. folio, Plates I.-VI.)

Since this is by far the most important work that has yet appeared on Tsetse-fly Disease as affecting animals in Africa itself, besides being, in conjunction with the no longer accessible "Preliminary Report," of epoch-making interest as the memoir in which the disease was first proved to be due to a hæmatozoon, it seems advisable to give a detailed analysis of its contents.

The Report is prefaced by a covering letter—"To His Excellency The Hon. Sir Walter Hely-Hutchinson, K.C.M.G., Governor of Natal and Zululand, etc., etc.," in which the author, after stating that, in accordance with His Excellency's instructions, he "left Pietermaritzburg on the 21st August, 1895, and arrived at Ubombo, Zululand, on the 8th September, 1895, for the purpose of investigating the Tsetse-Fly Disease, or Nagana, as it occurs in Zululand"—gives the following statement of its contents:—

"1.—A description of the Tsetse-Fly, with experiments designed to show the part this Fly takes in the causation of the disease.

"2.—A description of the Hæmatozoon or Blood Parasite, which is the cause of the disease.

"3.—The results of experiments having for their object proof of the connection which exists between the Big Game and the spread of the disease.

"4.—A description of the disease as it affects domestic animals, with illustrative cases.

"5.—Inoculation and feeding experiments to show the communicability of the disease from affected to healthy animals.

"6.—Treatments of the disease, prophylactic and curative."

The "Report" is illustrated with six plates (in addition to temperature charts) as follows:—

Plates I. and II. are devoted to the "Tsetse-Fly."

Plate I. contains the following *coloured* figures:—

1.—Fly at rest (natural size).
2.—Larva (natural size).
3.—Puparium (natural size).
4.—Fly at rest (× 2).
5.—Fly with expanded wings (× 2).
6.—Fly before feeding (× 2).
7.—Fly after feeding (× 2).

Plate II. is devoted to reproductions from photographs, as follows:—

1, 2.—Fly with expanded wings.
3.—Fly at rest.
4.—Fly pregnant with larva.
5.—Fly during parturition.
6.—Pupa.
7, 8.—Flies in various positions.

As has already been remarked in the systematic portion of this work (p. 89), the photographs appear to have been taken from specimens of *Glossina pallidipes*, Austen, while the coloured figures seem to represent *Gl. morsitans*, Westw.: the apparent discrepancy may be due to minor inaccuracies in the coloured figures.

Plate III. shows hæmatozoa in the blood of the dog, horse, and cow, "all magnified 1,000 times."

Plate IV.—"Horse suffering from Fly Disease or Nagana."

Plate V.—"Donkey suffering from Fly Disease or Nagana."

Plate VI.—"Dog suffering from Fly Disease or Nagana."

CONTENTS.—

	PAGE
1.—Definition	1
2.—Nomenclature	1
3.—Distribution in Zululand	1
4.—Historical Account	2
5.—Etiology	2
A.—The Tsetse-fly	2
1.—Description of	2
2.—Experiments with	4
3.—The Hæmatozoon or Blood Parasite of the Fly Disease	17
B.—Relation of the Big Game to the Fly Disease	19
6.—Description of the Fly Disease or Nagana as it occurs in the Domestic Animals	24
A.—In the Horse	25
B.—In the Donkey	30
C.—In Cattle	33
D.—In the Dog	37

PAGE
7.—Inoculation of Blood from Affected to Healthy Animals 41
A.—Inoculation of Blood in which the Hæmatozoa can be demonstrated by the Microscope 41
B.—Inoculation of Blood in which the Hæmatozoa cannot be demonstrated by the Microscope .. 45
8.—Feeding Experiments 46
9.—Treatment, Medicinal 46
A.—Arsenic as a Curative Agent 47
B.—Arsenic as a Prophylactic Agent 64
10.—Concluding Remarks 66

The following is the author's "Definition" of Tsetse-Fly disease:—

"The Fly Disease or Nagana is a specific disease which occurs in the horse, mule, donkey, ox, dog, cat, and many other animals, and varies in duration from a few days or weeks to many months. It is invariably fatal in the horse, donkey, and dog, but a small percentage of cattle recover. It is characterised by fever, infiltration of coagulable lymph into the subcutaneous tissue of the neck, abdomen or extremities, giving rise to swelling in these regions, by a more or less rapid destruction of the red blood corpuscles, extreme emaciation, often blindness, and the constant occurrence in the blood of an infusorial parasite, either identical with or closely resembling the *Trypanosoma Evansi* found in Surra, a disease of India and Burma. On *post-mortem* examination the following changes are noticed; deposition of a yellow jelly-like material in the subcutaneous tissue, intermuscular layers, and under the serous covering of the heart; with purplish stains or ecchymoses in various regions, as on the inner aspect of the skin, the serous membrane covering the lungs, and outer and inner surfaces of the heart; enlargement and softening of the spleen and congestion and fatty degeneration of the various organs" (p. 1).

Meaning of the term "Nagana."—"Nagana" is a Zulu word meaning "to be low or depressed in spirits," and has reference to "the symptoms presented by the animals suffering from the disease" (p. 1).

In the Congo Free State the disease is known as "la mouche" (p. 1).

Distribution of the disease in Zululand.—"Broadly it may be stated that the disease is limited to certain tracts, the physical conditions of which imply heat and moisture. These tracts in Zululand are situated in the level coast plain which extends some fifty miles inland, and in the river valleys which enter or debouch on this plain" (p. 1).

"Etiology.—The opinions of the Europeans settled in Zululand and of the natives themselves are so conflicting that little or no good will be gained by entering fully into their evidence.

"Two theories are held.

"A.—That the disease is caused by the bite of the Tsetse-fly. This is the European theory, and, as everyone knows, has been popularly prevalent ever since white men first landed in South Africa.

"B.—That the disease is caused by the presence of large game, the wild animals in some way contaminating the grass or drinking-water by their saliva or excretions. This may be called the native theory" (p. 2).

A.—The Tsetse-Fly.—The Tsetse "acts as a carrier of a living virus, an infinitely small parasite, from one animal to another, which entering into the blood stream of the animal bitten or pricked, there propagates and so gives rise to the disease" (p. 2).

Position of the wings when the fly is at rest.—"When the Tsetse is at rest the wings fold over one another like the blades of a pair of scissors, and give the fly an elongated appearance (Plate I., figs. 1 and 4)" (p. 2).

Mode of reproduction.—"The Tsetse-fly does not lay eggs as do the majority of the Diptera, but extrudes a yellow-coloured larva nearly as large as the abdomen of the mother. This larva is furnished with a black hood at one pole and two minute spikes at the other. It is annulated and consists of ten segments. Immediately on being born the larva creeps about with a good deal of activity, evidently searching for some cover or hole in which to hide. Having found a resting-place, it immediately begins to change colour, and after a few hours has turned into a jet-black hard pupa or nympha (Plate I., figs. 2 and 3).

"If these pupal cases are placed in a perfectly dry place, as in a wooden box, the perfect insect hatches out in about six weeks. From this it would appear that the life-history of this species of fly is very simple, it only being necessary for the female insect to deposit the larva on the surface of the soil or in the grass, when the larva creeps into the nearest shelter, in a few hours becomes hard and black, and in five or six weeks hatches out into the fully-developed Tsetse-fly.

"It has often been surmised that this fly is bred in buffalo dung, but from a consideration of the foregoing facts it is evident that nothing is wanted except any moderately dry place" (pp. 2–3).

Habits of Tsetse-flies.—"It is astonishing with what rapidity the flies fill themselves; in as small a space of time as twenty or thirty seconds a fly will become swollen out like a balloon with bright red blood.

"On entering 'Fly Country,' one is not left long in ignorance of the presence of the Tsetse. The natives may be seen slapping their naked legs, the dogs bite round, and the horses kick. The Tsetse, however, may be said to be somewhat local in its distribu-

tion in the Fly Country, being only met with now and then and in few numbers, until you enter some glade or clear space in the thorns, when suddenly the slapping, biting, and kicking go on with tenfold energy, and you can catch thirty or forty flies in a few minutes.

"The Tsetse has a direct flight, flopping, if I may use the term, suddenly on the animal attacked, and is very pertinacious. It affects in horses the legs, especially in the region of the fetlock, and on being detached from its position by the vigorous kick the horse gives, will only rise a few inches and again settle near the same spot. After the initial prick there is no irritation, and the animal will stand quietly while the fly has its feed.

"In man the burying of the proboscis in the skin is accompanied by a sharp prick, which draws one's attention suddenly to the spot; but the pain is, as a rule, trivial, and the subsequent redness and irritation very slight indeed—in fact, less than that caused by the mosquito.

"But under some circumstances the Tsetse may become almost unbearable. In January, when camping in the Fly Country close to the River Mkusi, these flies were very numerous, and in conjunction with the intense heat—the thermometer often registering 100° F. to 106° F. in the shade of a double tent—almost drove one mad. One can easily imagine the effect of the constant worrying of these pests by day, followed by mosquitoes at night, and minute ticks at all times, on any nervous system except the most stable. The horses fared no better, and could often be seen trotting about trying to escape from their tormentors.

"About sunset seemed a favourite feeding-time, and then the poor creatures would be surrounded by a perfect cloud of the flies, while some hundreds of them would be settled on them at the same moment.

"I have not noticed them biting during the night, but that excellent sportman and observer Selous states that by moonlight in some places they bite just as furiously as in the daytime.

"The fly makes a loud buzzing sound when flying, but after its feed and at rest it emits a peculiar sharp, shrill note, probably caused by an action of the wings.

"In horses, dogs, and cattle I have usually failed to find any swelling or symptoms of irritation following the bite, but on several occasions a well-marked soft swelling under the skin of the part bitten, as large as a hazel nut, was observed, and this persisted for some time.

"The Tsetse is not at all easy to catch with the hand, especially during the day, being nimble and quick of movement, but at early morning or sunset they become more lethargic, and are then more readily secured. When I wanted living specimens for any purpose I provided myself with a butterfly-net, with which it is easy enough to catch them unhurt.

"The Tsetse differs from the mosquito in that both sexes are blood-sucking flies.

"It is said that the fly follows the large game, but I never found them in any number in places in which a few minutes before large herds of buffalo or wildebeeste had been standing. Of course, the fly may have literally followed the game. One day, after killing a wildebeeste, I certainly found a large number of Tsetse on the dead animal, and again on a dead buffalo I counted as many as forty flies feeding on it at the same time" (p. 3).

Experiments with the Tsetse-fly (pp. 4–16).—These experiments are divided into seven series, and were made with a view to the elucidation of the following questions:—

"(*a.*) Is the Tsetse-fly capable of giving rise *per se* to any local or general disease in susceptible animals?

"(*b.*) Can the Tsetse-fly convey the disease from an affected animal to a healthy one?

"(*c.*) How long does the Tsetse-fly retain this infective power?

"(*d.*) How long does the blood of an affected animal remain capable of giving rise to the disease in a dried condition?

"(*e.*) How long does the blood of an affected animal remain capable of giving rise to the disease if kept in a natural condition?

"(*f.*) Does the Tsetse-fly under natural conditions convey the disease from animal to animal?

"(*g.*) Is the Tsetse-fly capable of giving rise to the disease if taken out of the Fly Country into a healthy locality?"

(*a.*) Details are given of three experiments in which various numbers of Tsetse-flies, brought from the Fly Country and then kept in captivity at Ubombo for some days, in order to give time for the hæmatozoon to disappear, in case it had been present in the bodies of the flies when they were caught, were subsequently fed daily on dogs during periods varying from ten days to two months. All the dogs remained perfectly healthy, and continued so after the experiments were stopped. The author adds: "The above experiments then prove, I trust satisfactorily, that the Tsetse-fly is not capable of giving rise *per se* to any local or general disease in susceptible animals" (p. 4).

(*b.*) In connection with the question: "Can the Tsetse-fly convey the disease from an affected to a healthy animal?" the author writes as follows (p. 5):—

"That all blood-sucking flies are not capable of transferring the Fly Disease from affected to healthy animals is, I think,

shown by the fact that up here at Ubombo, where we have several species of these pests, no single instance of the disease arising spontaneously has occurred, although healthy horses, cattle, and dogs have been constantly and closely associated with those suffering from the disease. Why this should be so is at present a mystery, and it is to be hoped that some point may be discovered which will throw light on the subject. There may be some anatomical peculiarity in the Tsetse which enables it to act as carrier, or there may be some undiscovered fact in the life-history of the parasite associating it with this particular species of fly.

"One fact, however, must be borne in mind, and that is the enormously greater number of Tsetse-flies in the Fly Country than any other species of blood-sucking fly met with there. I have seen as many as 200 Tsetse-flies on a horse at the same time; and when it is stated that I have often caught and put into a cage singly some fifty Tsetses in half-an-hour, some conception may be gained of the enormous number of Tsetse-flies which may visit a horse during its sojourn for one day in the 'Fly.'

"The act of feeding is remarkably quick. From the moment of settling on the animal until the fly is fully blown out with blood is often as little as twenty to thirty seconds. But still this does not explain why none of the healthy animals up here on the top of the Ubombo have become infected by their diseased neighbours, because we have many small stinging flies—some species probably of *Stomoxys*—which cause drops of blood to exude from the legs and ears of our animals. But this I can assert, and it is an important point, that in no single case, as far as I am aware, has any case of the disease occurred up here due to infection from the diseased to the healthy.

"That the Tsetse-fly can act as a carrier of the parasite is, I think, shown by the following experiments."

Details, with charts, are given of two experiments in which eight flies were allowed to feed on a healthy dog immediately after having fed for a short time on a dog suffering from the disease. The procedure was repeated on several days, and in each case on the sixth day after the flies were last fed the dog was found, by microscopical examination of his blood, to be suffering from the disease. The author adds: "Up to the present then from these two series of experiments it is seen *in the first place that the fly* per se *does not give rise to any local or general disease*, and this is further borne out by other experiments in which I placed minced up flies under the skin of dogs without any results, *and secondly it proves that the fly can act readily as a carrier of the Fly Disease from affected to healthy animals*" (p. 6).

"(c.) How long does the Tsetse-fly retain this infective power?

"Now as one of the main objects of this investigation is to

establish the part, if any, that the wild animals play in the dissemination of this disease, and as my working hypothesis at present is that some species of animals living in the Fly Country harbour the Nagana parasite in their blood, and that the Tsetse-fly carries the infection from affected to healthy animals, much in the same way as the vaccinating needle carries the infection of vaccinia from child to child, it will evidently further this object, if it can be discovered how long the Tsetse-fly retains its infective power. In passing through Fly Country of course it is possible that a Tsetse-fly may be feeding on a wild animal one minute and the next have transferred itself to the horse, ox, or dog; but if it can be proved to retain the power of infection say for twenty-four hours, the fly's power to do harm is evidently much widened" (p. 6).

Details, with one chart, are then given of three experiments on native dogs, in which various numbers of Tsetse-flies, from six to twelve, were repeatedly fed on the subject of the experiment, twelve, twenty-four, and forty-eight hours respectively after feeding on an affected animal. The results were that hæmatozoa were found in the blood of the dog on the 37th day, with the twelve-hour interval; on the 38th day, with the twenty-four hour interval; and on the 32nd day, with the forty-eight hour interval; reckoning in each case from the date of the commencement of the experiment.

"(*d.*) How long does the blood of an affected animal remain capable of giving rise to the disease in a dried condition?

"This point may be approached from another direction and some control placed on the results. Instead of using the proboscis of the Tsetse as the conveying instrument, let us use short pieces of thread dipped in blood containing the hematozoa, dried, and at varying periods of time threaded, by means of a needle, under the skin of healthy dogs" (p. 8).

Details, with charts, are given of seven experiments in which this procedure was carried out with varying results, as to which the author writes (p. 10): "These experiments would go to show that the blood of animals affected by Fly Disease retains its capability of transmitting the disease in a dried condition for twenty-four hours, but that this is exceptional, and that at the end of forty-eight hours the blood is inert.

"But as the proboscis of the Tsetse may retain blood in a moist condition, it will be interesting to show how long the blood itself, taken aseptically and preserved by suitable means from putrefaction, will retain this infective power.

"(*e.*) How long does the blood of an affected animal remain capable of giving rise to the disease if kept in its naturally moist condition?"

Here follows a statement (with one chart) of the results of eight experiments, as to which the author remarks: "These experiments point to the fact that the blood of animals suffering from Fly Disease can retain its infective power for four days but not for seven" (p. 11).

"(*f.*) Does the Tsetse-fly under natural conditions convey the disease from animal to animal?

"Having seen that the Tsetse-fly cannot of itself give rise to disease; that, on the other hand, it can readily act as a carrier, and that it is able to retain its infective power for at least twenty-four hours, let us now consider whether in a state of nature it really does convey the disease" (p. 12).

Details and charts are given of five experiments in which perfectly healthy horses were taken down into the Fly Country for a few hours, and were there allowed to be bitten freely by Tsetse-flies, but were not permitted to eat or drink until their return to the top of the hill. All the horses contracted the disease, and the author writes:—"These five experiments show abundantly *that horses cannot be taken with impunity for a few hours into the Fly Country, even although they are not allowed to eat or drink there*, and they afford a strong presumptive proof that the disease is carried to them by the Tsetse-fly.

"This last series of experiments, however, proves less than at first sight it might be supposed. It only proves that susceptible animals cannot be taken into the Fly Country, even although they are not allowed to eat or drink there. It does not absolutely prove that the disease is carried to them by the Tsetse-fly. There may be other ways of taking the disease, for example, by inhalation. . . . This is a hard thing to understand, and in order to make it possible the parasite of the Fly Disease must be able to exist in some other form than that in which it is found in the blood. The supposition would be that it forms a resting-stage or spore form in which it can exist as a dry, impalpable dust. For my part I have much difficulty in believing that animals are infected as a rule with Fly Disease by inhaling the *materies morbi*, and until I find animals still susceptible to the disease which are protected in some way or other both from feeding and the fly, I shall continue to be sceptical.

"On account then of the lack of absolute proof furnished by the last experiments, I set myself on the 22nd November to try to infect susceptible animals with the disease by having them bitten by flies brought up daily from the low country and straightway placed on the animals.

"(*g.*) Is the Tsetse-fly capable of giving rise to the disease if taken out of the Fly Country into a healthy locality?

"The method of carrying out this experiment was to go down

to the Fly Country in the early morning, catch the flies, return to the top of the Ubombo, and straightway place them on the animal under experiment.

"The greatest care was taken that the flies were placed on a perfectly healthy animal, as to have allowed them to puncture one already affected by the disease would naturally vitiate the experiment.

"The time which elapsed between catching the flies and placing them on the animal under experiment varied from four to seven hours" (p. 15).

Details and charts are given of two experiments, one on a horse, the other on a pointer dog. The animals were allowed to be bitten in the manner indicated by a varying number of flies on different dates, with the result that both contracted the disease.

With reference to the outcome of the experiments the author remarks:—"As these experiments have had a successful result, I now consider it proved that the Tsetse-fly does commonly, in a state of nature, convey the disease from animal to animal, and that on the other hand there is no proof that the drinking of water or the eating of soiled herbage plays any *rôle* in the process" (p. 16).

Pages 17 to 19 are devoted to "The Hæmatozoon or Blood Parasite of the Fly Disease."

With reference to the possibility of the existence of a resting-stage, the author writes:—"We have seen by the thread experiment that the hæmatozoa retained their vitality only on one occasion for twenty-four hours in a dried condition, and for less than seven days in a moist condition, and that after this they were no longer capable of giving rise to the disease. This proves that under these conditions there had been no spore or resting-stage formation" (p. 18).

As to "*The fate of the Hæmatozoa when ingested by the Tsetse-fly*," Col. Bruce remarks:—

"*A priori*, one would think that the hæmatozoa on being taken into the stomach of the Tsetse-fly would soon perish on account of the processes of digestion which one imagines going on. It will therefore be interesting and bear directly on the subject if we trace the history of the hæmatozoon after it has been removed from the blood-vessels of an affected animal and swallowed by the Tsetse-fly. I therefore caused the flies to feed on an animal suffering from Nagana, whose blood contained numerous hæmatozoa, and at hourly intervals subjected the proboscis, the contents of the stomach, and the contents of the lower end of the intestine to microscopical examination.

* * * * *

"The result of my examination up to the present of the Tsetse-fly is briefly this :—

"Immediately after feeding, the tube of the proboscis can be seen to be crammed full of red blood corpuscles, among which the hæmatozoa can be seen actively wriggling. Up to 46 hours after feeding I have seen living hæmatozoa and red blood corpuscles in the proboscis. After 118 hours the hæmatozoa are still very numerous and vigorously active in what remains of the blood in the stomach. After 140 hours the stomach is empty. After 25 and 70 hours I have seen many motionless hæmatozoa in the fæces, but I have never seen at any time any appearance of life in the hæmatozoa in the fæces or contents of the lower part of the intestine. The parasites appeared, however, unchanged in form, and I intend making some injection experiments with the fæces to find out if these motionless hæmatozoa have any vitality left in them" (p. 19).

Pages 19 to 24 are devoted to the second part of the account of the etiology of Nagana, viz. :—

"B.—Relation of Big Game to the Fly Disease.

"As we have found that the Tsetse-fly in a state of nature does act as a carrier of the hæmatozoa of Fly Disease, it is evident that it must procure the parasite somewhere, and what more natural than it should procure it from the blood of warm-blooded animals living in the Fly Country?

"It is not necessary to suppose that in these animals Nagana is a fatal disease, but only that the big game harbour the parasite which causes the disease for a longer or shorter time with little or no disturbance to health. We have seen, as in the case of the heifer mentioned on page 33, that cattle may have the parasite in their blood for at least eighteen months without causing death, and it is possible that some of the big game die of this disease. When in the Fly Country quite lately, I chanced on a dead wildebeeste surrounded by vultures. The skin of this animal was quite intact and showed no signs of its having come to a violent death. It was somewhat emaciated and had the appearance of an animal dead of Nagana. I did not inject any blood from it into a susceptible animal, as it was in a state of decomposition" (p. 19).

* * * * *

"In regard to this relation of big game to the Fly Disease, there can be no question as to the very widely spread opinion which exists regarding the wild animals as in some way or other responsible for its propagation, and in this connection the buffalo, wildebeeste, quagga, waterbuck and koodoo are usually named. Europeans and natives in all parts of the country are found who

state most emphatically that where there is no game there is no Nagana, and example after example could be cited of the statement that the game having been driven out, the disease disappeared, and on the reappearance of the game that the cattle again became sickly. Those who hold the Tsetse-fly theory explain this by affirming that where the big game is there also is the Fly. Others, as mentioned above, are of opinion that the game contaminate the grass and drinking-water and so infect the cattle.

"That the presence of the wild animals in the vicinity of horses and oxen is not the only factor in the problem is shown by the fact that in the old days when the big game was numerous and roamed over the whole country, hunters and travellers never complained of the Fly until they encountered the disease in low-lying tracts of country, or along the large river valleys; and at the present day it is stated, on the authority of Mr. L. Peringuey, that in the Hermansdorp District of Cape Colony, where herds of buffalo are still found, the Fly Disease is unknown, nor has the Tsetse-fly itself been ascertained to occur there. Now we know the disease to be caused by a blood parasite, and that the disease can be carried by the Tsetse from affected to healthy animals, we can see how such theories may have some foundation in fact.

"At first I thought that by a careful microscopical examination of the blood of the big game some light could be thrown on the subject, and to this end I submitted the blood of buffalo, wilde-beeste, koodoo, impala, bush-buck, reed-buck, and the smaller varieties shot in the heart of the Fly Country to a lengthened microscopical examination, but with no result.

"Thinking, however, that the parasite might exist in too small numbers, as we have seen is frequently the case in cattle, to be readily discovered by direct examination, I next instituted a series of experiments by injecting a moderately large quantity of blood, taken immediately after death, into dogs, as it has been proved by experiment that in cases in which the parasite could not be demonstrated by the microscope, an inoculation experiment of this kind readily discovered them.

"Of course, it was necessary that the dogs used for experiment should be kept at the top of the Ubombo, as the results would have been useless if they had been exposed to infection in any other way than by the injection of the blood.

"This meant a delay of several hours between the procuring of the blood and the injection of it into the dog, as the wild animal might be shot five or ten miles from the foot of the hills, and the Ubombo itself is some 2,000 feet high.

"Again, it would evidently facilitate matters if the blood could be kept liquid, as the blood coagulum might entangle in itself all the parasites contained in the blood.

"I therefore made a preliminary experiment to find out if

blood kept liquid by some suitable means, and kept in a bottle at the temperature of the air for several hours, would still retain its infective power" (p. 20).

In the preliminary experiment 10 c.cm. of blood were taken from a dog suffering from Nagana, mixed with "a twentieth of its bulk of a 0·5 per cent. citrate of potash solution," then kept "in a bottle at the temperature of the air (80° F.) for seven hours," and finally injected into a healthy native dog. Hæmatozoa of Fly Disease were found in the blood of the dog after five days, "and he died of the disease twelve days later."

"It was evident then that we might expect successful results by injecting blood procured in the Fly Country and kept liquid by the above-mentioned means into native dogs kept on the top of the Ubombo" (p. 21).

On pages 21 to 23 is given a statement, with results, of thirty-four experiments on native dogs, carried out on the above lines, with blood from various species of wild animals. An analysis of the results shows that in five cases the dog died from an unknown cause; in twenty-one cases the dog remained healthy; in eight cases the dog contracted fly disease.

On page 24, there is printed a tabulated statement showing "the results of the above and other experiments, the various species of wild animal being tabulated together."

The following is an analysis of the results :—

Out of eight dogs inoculated with blood from *buffaloes*, one dog contracted the disease.

Out of thirteen dogs inoculated with blood from *wildebeeste*, three contracted the disease.

Out of four dogs inoculated with blood from four *koodoos*, three contracted the disease.

Two dogs were inoculated with blood from *water-buck*, and both remained healthy.

Two dogs were inoculated with blood from two *impala*, and both remained healthy.

One dog inoculated with blood from a *Burchell's zebra* remained healthy.

One dog inoculated with blood from a *bush-buck* contracted the disease.

Three dogs inoculated with blood from a *stein-buck*, *wart-hog* and *wild-pig*, respectively, all remained healthy.

One dog inoculated with blood from a *hyæna* contracted the disease.

The author concludes this section of the "Report" with the following remarks :—

"These experiments I think prove that several species of wild

animals inhabiting the Fly Country harbour the Nagana parasite, and the links in the chain of the causation of this disease connecting the game through the Tsetse-fly with the domestic animals are complete.

"In regard to other points relating to the etiology of this disease, such as seasonal prevalence, sex, age, breed, etc., I may dismiss them in this Interim Report by the remark that, according to my present knowledge, neither season, sex, age nor breed has any predisposing or protective influence in this disease" (p. 24).

Pages 25 to 41 are devoted to a—"DESCRIPTION OF THE FLY DISEASE OR NAGANA AS IT OCCURS IN THE DOMESTIC ANIMALS" (horses, donkeys, cattle, and dogs), with temperature charts, showing "fluctuations in the number of the blood corpuscles and parasites," and a "short description of the principal changes found on *post mortem* examination."

Fig. 14.

Dog suffering from Tsetse-fly disease, or Nagana (after Bruce).

Of the remaining portion of the "Report," pp. 41 to 45 are devoted to experiments on—"INOCULATION OF BLOOD FROM AFFECTED TO HEALTHY ANIMALS."—

A.—"INOCULATION OF BLOOD IN WHICH THE HÆMATOZOA CAN BE DEMONSTRATED BY THE MICROSCOPE" (pp. 41–45).

B.—"INOCULATION OF BLOOD IN WHICH THE HÆMATOZOA CANNOT BE DEMONSTRATED BY THE MICROSCOPE" (p. 45).

On p. 46 is given a statement of an experiment on—"FEEDING HEALTHY ANIMALS ON TISSUES FROM ANIMALS AFFECTED BY NAGANA." A native dog, after eating a piece of coagulated blood from the heart of a heifer, Exp. 216, was found to be suffering from the disease on the sixth day.

In connection with this experiment the author remarks:—

"In the Segane Valley, many of the dogs belonging to one of the kraals fed on the raw flesh of a quagga, and I am informed that several of these dogs subsequently died of Nagana.

"Mr. B. G. Lloyd also states that in the winter of 1892, Mr. Saunderson, of Spitz Kop, Z.A.R., took some oxen into the "Fly" hunting and lost them all, though one of them died after returning to the farm. Some dogs got at the dead bullock and

ate a lot of the meat raw. They all died within three months, showing all the signs of "Fly," whereas some pups which were kept shut up were fed on the same meat, but cooked, for several days, yet none of them showed any sign of being affected."

Pp. 46 to 66 are devoted to "MEDICINAL TREATMENT."

"A.—ARSENIC AS A CURATIVE AGENT" (pp. 47–64).

In connection with the experiments charts are given, showing fluctuations in temperature, and in the number of blood corpuscles and hæmatozoa, and the number of grains of arsenic administered daily.

"(1.) *Treatment in Horses*" (pp. 47–56).

The author writes (p. 47):—"Since I have been here at Ubombo I have tried the arsenical treatment on several horses, donkeys, and dogs, but in this Interim Report I would rather not make any general statement concerning the usefulness or otherwise of the drug, leaving rather the reader to draw his own conclusions from the experiments themselves. . . .

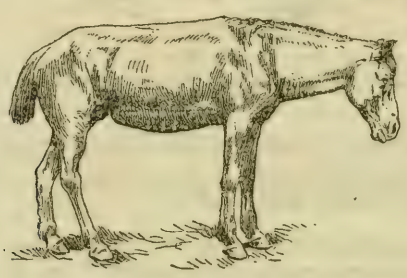

Fig. 15.
Horse suffering from Tsetse-fly disease, or Nagana (after Bruce).

"The horses were given the arsenic in solution. The arsenic was dissolved by heating in water with an equal quantity of carbonate of soda. I made the solution in the following strength:—Arsenic 6 grs., carbonate of soda 6 grs., and water 1 ounce. The ounce of fluid was merely sprinkled night and morning over his feed of crushed mealies, so that there was no trouble in the administration of the drug."

Since the subject of Tsetse-fly disease in horses is of general interest, it may be useful, without going into the details of the experiments, but as an indication of the results obtained, to quote a few lines from the author's "Remarks" at the conclusion of certain of the cases.

Exp. 205A.—(This horse eventually died of Horse Sickness.)

"This horse remained alive sixty-five days from the commencement of the disease, and then only succumbed to Horse Sickness. While under arsenic he very fairly retained his strength, as may be proved by the fact that he very often carried me (riding over fourteen stone) down to the Fly Country and back, when I went down to collect flies. This means being on the march from 5 A.M. until 5 P.M., with a climb in the afternoon of the Ubombo, which is some 2,000 feet above the plain."

Exp. 224.—(This horse likewise eventually succumbed to Horse Sickness.)

"It is evident that the arsenic had much less effect than in the previous case (Exp. 205A)."

Exp. 264.—"Horse, Bay.—'M.D.'"

"*Remarks.*—This case illustrates the uselessness of arsenic as a means of preventing "Fly Disease." Although "M.D." was well saturated with arsenic and smelt strongly of it, two short exposures to the "Fly" were sufficient to set up the disease. The first exposure was at Mkusi Drift, at the western end of the Mkusi poort, a drift which has usually been considered free from "Fly." This year many Tsetse-flies have been seen there, and several cases of Nagana have occurred among the animals crossing the Segane Valley to Ubombo. At the eastern end of the poort, and within a couple of miles of the drift, a herd of buffaloes have their headquarters, so that it can readily be understood how the flies find their way to the drift. As will be seen from the temperature chart, the arsenic has held the disease in check for some two months, but not sufficiently to prevent the right eye from becoming affected by an opacity causing blindness. The hæmatozoa are now beginning to reassert themselves, and the case will probably end fatally in a few weeks." [The horse eventually became unable to stand, or to rise, and was therefore shot.]

Exp. 278.—"Another case showing the futility of arsenic as a prophylactic agent."

Exp. 283.—"In this case arsenic is seen to be practically useless, both as a prophylactic and a curative agent."

"(2.) *Treatment in Donkeys*" (pp. 56–64).

"The donkeys were given arsenic in the dry condition, the mouth being opened by an assistant and the powder placed on the back of the tongue. There is no difficulty in administering it in this way" (p. 57).

In the five cases described all the donkeys, except one, eventually succumbed to the disease.

In "Remarks" on Exp. 257 the author writes:—"This case shows in a marked manner the effect of arsenic in prolonging life in this disease" (p. 61).

On Exp. 251 (the non-fatal case), in which the donkey, having been placed on 12 grains of arsenic on February 13th, after hæmatozoa had been discovered in its blood three days earlier, was still alive on July 19th, in spite of several visits to the "Fly Country" in the interval, the author's "Remarks" are as follows:—

"The preceding chart gives the principal facts of what is up to the present the most successful case I have had of treatment by arsenic. After five days of treatment the hæmatozoa are seen to disappear from the blood and not to return for a period of almost five months. The red blood corpuscles, which in February lie between three and four millions per cubic milli-

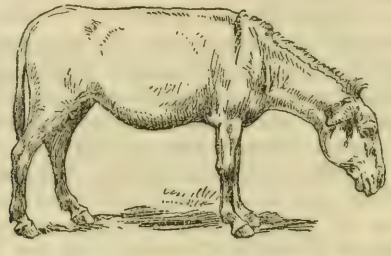

Fig. 16.
Donkey suffering from Tsetse-fly disease, or Nagana (after Bruce).

metre, are seen to gradually rise in numbers to five millions. Corresponding with this there has been a gradual increase in fitness, and at present the donkey has all the appearance of a perfectly healthy animal. The arsenic was stopped on the 17th May, but the hæmatozoa reappeared on July 10th, when the animal was again placed on arsenic" (p. 64).

"B.—Arsenic as a Prophylactic Agent" (pp. 64–66).

The author commences this section with the following paragraph:—

"As has been seen in the cases in which arsenic was given as a curative agent, the drug undoubtedly markedly modified the course of the disease. It, therefore, seemed probable that the disease would be prevented altogether if the arsenic were given for some time previous to the animal being exposed to the infection. If twelve grains of arsenic given daily can cause the hæmatozoa to disappear rapidly out of the blood, it is difficult to imagine how they could appear in the first place if the animal before entering the Fly Country had been given this quantity of the drug for some time previously. But twelve grains daily is a

very large dose of this powerful drug to give to a healthy horse, and probably cannot be given in every case without setting up inflammation of some of the internal organs, with falling away in condition, and general debility" (p. 64).

After giving details of five experiments made to determine the point, the author sums them up with the following observation:—"From these experiments it may be concluded that arsenic is quite useless as a prophylactic agent, but that it is useful in prolonging life and usefulness in the Fly Country after the disease has begun" (p. 66).

"10.—Concluding Remarks" (pp. 66–69).

After discussing the various ways in which an infective disease may be attacked, the author goes on to say:—

"To return to Nagana, what do we know of the disease? We know that it is caused by the entrance into the blood of a minute parasite which multiplies there and causes death; that this parasite exists in the blood of many animals and that it is conveyed from animal to animal by the Tsetse-fly, or by the eating of the raw flesh of animals affected by the disease. We also know that the disease is limited to certain tracts of country having certain physical features, but that its distribution in these tracts is very variable.

"We do not know how the parasite causes death, but surmise that it may do so by the poisonous action of some substance or substances elaborated or secreted by it, or by producing a progressive hæmolysis and anæmia, leading to a form of auto-intoxication. We do not know all the animals in which this parasite may exist, but judging from the number of domestic animals in which it is fatal, we may consider that it has a wide range. It may exist not only in the koodoo, wildebeeste, and other big game, but it may also exist in the wild cats, rats, birds, and even fish of the Fly Country.

"We do not know whether there are other species of fly which convey the disease besides the Tsetse, but this perhaps is a minor consideration. We do not know of any method at present of isolating the hypothetical poisonous substance elaborated by the hæmatozoon so as to be able to study it or to render animals immune to it by gradually increasing doses. No experiments have, as far as I am aware, been made in this country in the direction of studying the effect of the serum of animals in whose blood the hæmatozoa have been numerous. Dr. Lingard has, however, made a few with a negative result in Surra" (p. 67).

Remarking that treatment of disease by means of serum "is very popular at present," the author proceeds to quote *in extenso* the results of Dr. Lingard's experiments on:—"The subcutaneous inoculation of blood and its derivatives in its different forms,

obtained from animals suffering from, or which had lately succumbed to, Surra" (pp. 67–68).

After this extract from Lingard, Col. Bruce observes:—

"Up to the present then the results of experiments with serum have been negative, but I purpose if time permits to continue this line of investigation.

"Another important point we are still ignorant of is whether animals can become affected by this disease without the agency of the Tsetse-fly or by eating raw flesh, as, for example, by drinking contaminated water or eating soiled herbage. This point I am engaged in investigating. And, lastly, up to the present we do not know of any drug which will prevent the disease or cure it in every instance when incurred" (p. 68.)

The author concludes with the following "suggestions" as to the lines on which future work in connection with Tsetse-fly disease should be conducted:—

"1. That all trustworthy information regarding seasonal prevalence be collected.

* * * * *

"According to the 'Natal Almanack,' the dry season includes the months of April, May, June, July and August; the wet season September, October, November, December, January, February and March. As far as I am aware, Nagana is not confined to certain months of the year as Surra is, but I should like to have more definite information on this point.

"2. Towards the end of the dry season or when the water pools are nearly dried up, can the *Trypanosoma* be discovered in this concentrated water by the microscope or by feeding or injection experiments?

"3. The question of herbage.—Dr. Lingard states that in India after the rains have commenced the resting forms of the organism which have been clinging to the grass bordering upon the water-holes begin to soften, and when the animals feed on such vegetation, repeated doses of the contagium are taken into the stomach. It is probable that the small discs gradually gain an entrance into the blood stream and their development takes place in the liver, spleen, and glands generally. All grass-eating animals, therefore, may be the subjects of Surra, so that the opinions held with regard to the big game by the natives are possibly founded on fact.

"In Africa we are, as yet, in dense ignorance respecting the resting-stage of the Fly hæmatozoon; this would be a most important point to work up. In regard to the herbage, will such grass and water brought up from the Fly Country give rise to the disease in healthy animals kept in a healthy locality?

"4. It would be important to find out as far as possible what species of wild animals, vultures, barbel, etc., harbour the parasites.

"5. As many examinations [as possible] of the blood and fluids in the body-cavity of the Tsetse-flies should be made and the result noted. Injections of fluids in which several flies have been mashed up might also give results.

"6. How long do the hæmatozoa retain their vitality in the body of a dead animal?

"7. How long do the hæmatozoa retain their vitality in ordinary pond water?

"8. The Fly Disease in the native sheep and goat has to be worked up. I have up to the present been unable to procure these animals from the natives here.

"9. Further information is wanted regarding the breeding of the Tsetse-fly.

"10. Are the young of animals affected by the 'Fly' in any way immune to the disease?

"11. Sir Walter Hely-Hutchinson informs me that he has heard it stated that animals can be rendered immune to Tsetse by taking them into the Fly when young, at intervals. Is there any truth in this statement?

"12. Will the passage of the parasite through a series of animals influence its morbific power?

"13. Would large quantities of the serum of wild animals, say the wildebeeste, have any influence on the course of the disease if injected under the skin or into the peritoneal cavity of the animal affected by the disease?

"14. Can anyone study the disease in tamed wild animals, for example the koodoo or any of the smaller buck? . . .

"15. Why should the wild animals be spared whilst tame animals suffer? What is it in domesticity that removes immunity? Can the domestic animal be supplied with what is present in the wild? Can this something be discovered?

"These, then, are a few of the problems to be solved in the 'Fly' question . . ." (pp. 68–69).

APPENDIX B.

"A Note on the 'Tse-Tse' Flies of the British Central Africa Protectorate." By Captain Richard Crawshay.

The following "Note," which refers mainly to *Glossina morsitans*, Westw., and *Gl. pallidipes*, Austen, was kindly written at the author's request by Captain Richard Crawshay, during a sojourn in London in June, 1896, on his return from Nyasaland.

"'Tse-Tse' were formerly met with almost everywhere throughout what is now known as the B. C. A. Protectorate; but of late

years have decreased very much in the Eastern portion, or have even become extinct in some localities, owing probably to the disappearance of the larger game, such as elephants, rhinoceros, and buffalo.

"During my earlier visits to this part of Africa, between 1883 and 1890, I encountered them practically wherever I went:—*e.g.*, on the Lower Shiri River, numerous in the Elephant Marsh so lately only as in 1891—the last time I was there; on the Blantyre-Matope Road, on the Lirangwi flats at Sambamwali and Nachimvu; very numerous opposite Matope on the Upper Shiri, where buffalo were very plentiful; and wherever, almost, one touched on the W. Coast of Lake Nyasa—notably at and around Deep Bay.

"Nowhere in the eastern portion of the Protectorate do I recollect having seen them very numerous, unless perhaps opposite Matope; nor have I experienced any great annoyance from their bites, as compared with the torture one has undergone in the western region. There, in 1891 and 1892, I found them a terrible ordeal in the country lying between the S.W. portion of Lake Tanganyika ('Liemba' of the natives) and Lake Mweru. In Kabwiri they simply swarmed: I shall not soon forget the Mofwi Valley and the Kalongwizi Flats!

"Many people are of opinion that 'Tse-Tse' do not bite man, or that if they do their bite is not painful. This theory is soon dispelled in the Mweru country. There, marching at the head of my caravan—as one does, to be ready for game—I have had as many as forty or fifty 'Tse-Tse' at me at the same time. Life was not worth living on the march: there was no getting a moment's peace: a large leafy branch had to be kept going incessantly round one's head, neck, and arms, and even then one received many bites. 'Tse-Tse' are most active and vicious assailants, and there is no limit to their perseverance; they care nothing for the flip of a fly-switch or a leafy branch, neither are they easily felled to the ground with a slap of the hand, but fly off apparently none the worse: a blow sufficient to fell an ordinary blue-bottle will not fell the 'Tse-Tse.'

"It will convey some idea of how bold they are when I say that they will creep in under one's shirt, when open at the chest, and are not disturbed by the garment touching them.

"During the hottest hours of the day they are most aggressive, but they bite at any time, even at night, when it is bright moonlight. Their flight is powerful and noisy: the buzz is full-toned and somewhat highly pitched:—not dull and droning like the buzz of the ordinary horse-fly: they do not settle as slowly as the horse-fly, but land with a bump, standing well up on their legs. When a 'Tse-Tse' settles with the intention of feeding—in the early mornings they usually simply settle on men's backs to sun themselves, away from the ground and vegetation wet with the dew—he inserts his proboscis, lowers his head, and raises his abdomen until it is almost vertical: when doing this,

and for some little time after he has commenced sucking, he works his wings, buzzing in a minor key, rather like a bee when held forcibly, though not so powerfully: when the keenness of his appetite has been somewhat appeased, he stops working his wings and sucks in silence. If left to himself, he will suck until his originally skinny barred abdomen becomes a large crimson bead. He is then almost helpless: if touched he will not fly, and if brushed off he will only go a yard or two, to settle heavily on a bush, or gradually sink down to the ground.

"A common habit of 'Tse-Tse' is to sit on paths and game-tracks, by day and on moonlight nights. They then fly up and attack the first person who comes along, and follow him up in an ever-increasing swarm, so that the leader of a caravan will soon have forty or fifty about him; whereas the men behind will hardly have one.

"In 1893–1895, I took 'Tse-Tse' [*Glossina morsitans*, Westw. —E. E. A.] in Henga—the highlands to the S.W. of Deep Bay, the altitude of which is some 3,300 feet. There are not many there now: I doubt if one could take a dozen in a day. Those I collected were most of them taken at the foot of Jakwa Mountain, close to the junction of the Rukuru River with the Lunyina; but they were to be found along the entire course of the Lunyina River, even in the gorge through which it flows into the lake, where there are still buffalo.

"The Ahenga, Ankamanga and Atumbuka know this insect as 'Kasyembi.' The Awemba, of Itawa and Kabwiri, know it as 'Chisemberi': pl. 'Visemberi.'

"The Arabs and Coastmen had a wholesome dread of the 'Tse-Tse' of the Mweru Country: I was warned what to expect in Kabwiri by Abdallah bin Suleiman, of Kavuta, two or three days before I encountered them in any numbers. In the Upper Loangwa River Valley, some seven days' journey south-west from the north end of Lake Nyasa, 'Tse-Tse' were plentiful in August and September last year. I collected specimens which Mr. Austen has determined to be *Glossina morsitans*, Westw. The altitude of this part of the Loangwa Valley is 2,250 feet; there is a great deal of game there, including elephants in the rains.

"In February, 1895, when visiting the recently established Administration post at Kaporo, at the north end of Lake Nyasa, I caught some very large 'Tse-Tse'* belonging to a species new to me, much larger and darker than *Gl. morsitans*. These I found sitting on the path at sunset: they did not bite. Two specimens of these I sent home, a third I have by me."

RICHARD CRAWSHAY.

LONDON,
June 17th, 1896.

* *Glossina fusca*, Walk., *q.v.*—E. E. A.

APPENDIX C.

COPIES OF LETTERS ON THE SUBJECT OF THE SUPPOSED CONNECTION BETWEEN THE TSETSE AND THE BUFFALO (*Bubalus caffer*, Sparrman): transmitted by the Foreign Office to the British Museum (Natural History).

MWENGA R.,
"Hook of the Kafue,"
N.E. Rhodesia,
24*th February*, 1901.

MR. VAL GIELGUD *to the* SECRETARY OF THE BRITISH SOUTH AFRICA COMPANY.

SIR,—I see from the papers that the international conference for the preservation of big game has decided to recommend that Buffalo be placed on the list of game to be absolutely protected. I, therefore, wish to bring to your notice my observations on the Tsetse-fly and the Buffalo, the correctness of which are, I believe, borne out by the experience of Mr. George Grey when travelling through a fly country in 1899 and also by information obtained from native sources.

The Tsetse-fly has always abounded in districts where Buffalo were numerous, and since the almost total destruction of Buffalo by rinderpest these flies have not disappeared, although, perhaps, not so numerous as formerly. The bite of the insect, however, appears to have become much less deadly to domestic animals, and stock and dogs not only survive the bites for a much longer period than formerly, but in many cases suffer no ill effects at all.

This has been my personal experience, and I think I am correct in saying that Mr. Grey's is similar.

The natives say that now the Buffalo are dead the Tsetse-fly no longer kills stock, but of course natives are notoriously careless and loose in their statements. It is a fact also that in many places where Buffalo have become extinct the Tsetse-fly has also vanished; this is the case in parts of Sebungwi and Zankie districts. As there are large fly districts in northern Rhodesia I call your attention to these facts, as it appears to me that the protection of the Buffalo and the Tsetse-fly are identical, and I would doubt if the benefit accruing from the preservation of the former will compensate for the disadvantages arising from the existence of the latter.

I am, etc.,
VAL GIELGUD.

Mombasa,
6th September, 1901.

Sir Charles Eliot, K.C.M.G., C.B., *to the* Marquess of Lansdowne, K.G., etc., etc.

My Lord,—In reply to your Lordship's despatch, No. 259 of July 20th, respecting the connection between the Tsetse-fly and the Buffalo, I have the honour to transmit letters from Messrs. Stordy and McClellan and Doctor Radford.

After reading this correspondence and discussing the question with other persons, my own opinion is that where there are Buffaloes, Tsetse-flies are usually (but not always) found, but that the flies also occur in districts where there are no Buffaloes. Hence it would appear that the Buffalo cannot be the only host of the parasite which the Tsetse-fly introduces into the blood of domestic animals with fatal results.

I have, etc.
(Signed) C. Eliot.

Nairobi,
East Africa Protectorate,
3rd September, 1901.

R. J. Stordy, M.R.C.V.S., *to* Sir Charles Eliot, K.C.M.G., C.B., His Majesty's Commissioner and Consul General, Mombasa.

Sir,—I beg to acknowledge receipt of a copy of the correspondence *re* Tsetse-fly and the preservation of the Buffalo which you forwarded to me for my opinion, and I have the honour to transmit to you herewith my observations on the subject.

The Tsetse-fly belt of British East Africa, exclusive of Juba-land, may be said to extend from Mtoto Andei to Simha, a distance of roughly ninety miles; it is situated in a densely-wooded, low-lying part of the country, about 3000 feet to 3400 feet above sea level.

Driajani, an old camping ground, within this area, was considered by the late Captain Haslam and myself to be the most dangerous place for fly on the old transport route, but strange to say it was practically devoid of game of any kind.

In my opinion, Buffalo and other big game are not the only factors in the Tsetse-fly theory, and we must first consider the question of climate and humidity before we condemn the *Bos caffer* as the true and only source of the Tsetse-fly disease.

I believe that the distribution of the fly is entirely influenced

by the physical aspects of the country and that for its existence it must have a humid, low-lying position.

Major Bruce in his excellent report ("Further Report on Tsetse-fly Disease and Nagana in Zululand," 1897, p. 20), says: "That the presence of wild animals in the vicinity of horses and oxen is not the only factor in the problem is shown by the fact that in the old days when big game was numerous and roamed over the whole country, hunters and travellers never complained of fly until they encountered the disease in low-lying tracts of country or along the large river valleys."

As in the Hermansdorp district of Cape Colony herds of Buffalo are still to be found, yet Tsetse-fly with its concomitant disease is unknown, so in the high altitude of the Kedong 6000 feet), in this Protectorate, herds of Buffalo are to be met with, greatly reduced in numbers by rinderpest within recent years it is true, yet neither Tsetse-fly nor Tsetse-fly disease have ever been known to occur, nor has the fly or its disease been heard of in the Baringo district of the Uganda Protectorate, where herds of Buffalo and other big game exist.

When studying the causes which rendered the Island of Mombasa uninhabitable for horses, I ascertained that an organism, the morphology of which was identical with that found in animals suffering from Tsetse-fly disease, was found in donkeys which had never left the island.

I expressed an opinion then (*vide* "Preliminary Report as to the causes which rendered the Island of Mombasa uninhabitable for horses in 1899") with regard to African Nagana and Indian Surra being one and the same disease, and as the occurrence of Surra cannot be attributed to the presence of wild animals or Tsetse-fly, we must explain, ere we destroy the buffalo in an attempt to stamp out Nagana, why a disease identical with that caused by the bite of the *Glossina morsitans* occurs in places such as Mombasa, where Tsetse-fly and buffalo are non-existent.

I have, etc.,

(Signed) Robert J. Stordy, M.R.C.V.S.
(Vety. Officer, E.A.P.).

Nairobi,
East Africa Protectorate,
3rd September, 1901.

Dr. Radford *to* R. J. Stordy, Esq., M.R.C.V.S.

Dear Mr. Stordy,—Many thanks for sending me the communications you have received from Sir Charles Eliot, *re* the Buffalo and Tsetse-fly.

That the two should be associated is not extraordinary when

one remembers that both inhabit densely-wooded, damp, secluded districts, but the arguments advanced to prove that the *Bos caffer* alone is the host of the Tsetse, and that the extermination of the former leads to the disappearance of the latter do not appear to me to be convincing. From my own observation I am inclined to the opinion that hosts other than the one species mentioned (or some other factors) are necessary for the propagation of the fly, and that the hæmatozoon is in all probability to be found in many species of diptera.

During my residence in Jubaland, East Africa Protectorate, which extended over two years, I had ample opportunity of studying the habits and distribution of the Tsetse-fly and the effect it produced on domestic animals.

Speaking generally, the fly belt is confined to two distinct areas in that province.

(1) The valley of the Juba River within the forest belt. Here fly abounds for a distance of upwards of 400 miles—in fact, so general is it in places that it is a source of annoyance to Europeans and natives. Yet within the whole of that great tract of country Buffalo are few and far between. The late Mr. Jenner and I came across them in one place only (Lake Galey and district). Within this belt is the district of Gosha, 80 to 100 miles in length, where the fly is peculiarly abundant, yet Buffalo are not found; notwithstanding this, the hæmatozoon is very virulent, and on the occasion of the late Mr. Jenner's expedition to Lugh in 1899, he lost every camel and pack-ox that went through (*vide* my Report, May 16th, 1899, forwarded to the Secretary of State for Foreign Affairs, No. 53, May 31st, 1899).

(2) The region of Lake Kumbi to the north-east of Desek Wama (Lake Hardinge), where the distribution of the fly is restricted to the dense forest belt in the neighbourhood; yet Buffalo are not known to frequent this district. It appears to me reasonable to assume that where fly is abundantly found extending over a large tract of country that its natural host (if one only) should be in large numbers also; or else the fly must be possessed of extraordinary migratory powers.

If that host be the Buffalo, it is strange that it is particularly conspicuous by its absence in the extensive districts mentioned, while waterbuck and bushbuck are common in most parts, and yet again in others no animals of any sort are found save monkeys and rodents. Amongst other pests that affect camels very seriously in Jubaland is a species of gad-fly which is restricted in its distribution to the open plains and sparsely-bushed country in the districts of Desek Wama and Derib. This fly, unlike the Tsetse, attacks animals during the day at all hours, and the symptoms produced by it (in camels) are identical in every particular with those produced by Tsetse, but I was

unable at the time to substantiate this theory microscopically owing to lack of the necessary materials, etc., for carrying on investigations.

Yours truly,
WILLIAM S. RADFORD,
Medical Officer, East Africa Protectorate.

NAIROBI,
4th September, 1901.

MR. J. W. P. MCCLELLAN *to* SIR CHARLES ELIOT, K.C.M.G., C.B.

SIR,—Referring to our conversation on the subject of Tsetse-fly in the Jubaland Province, I would state that along the Juba River where low-lying forest exists (my observations cover a distance of some hundred and twenty miles from Bulbula to Gele) Tsetse-fly abounds. The worst places are damp, dark, and low-lying, shaded chiefly by the Ndoma Palm. In many such localities there is little or no game and certainly no Buffalo.

On the other hand, from Mtudo northwards Buffalo are found, especially in rainy weather and in the heat of the day frequent the thickest depth of the forest; here, too, Tsetse-fly is found in large numbers, as also in the dry lake beds adjacent to the river. At the same time half a mile or so away from the river and lake beds in the dense dry bush, where Buffalo feed in the early mornings and evenings, the fly does not appear. In many places the areas in which fly exist are quite small, possibly only a few hundred yards in extent, and I have seen a watering place made entirely free of fly for the time being by cutting down forest and undergrowth and burning the grass in the immediate vicinity. Again, at Lake Hardinge (now dry), where little or no forest exists, where Buffalo are frequently seen, and always large herds of waterbuck, and Somalis graze their cattle at all times of the year without ill effects. Passing on, however, some thirty miles to the Rumbi forest on the Affmadu-road, Tsetse-fly abounds, especially in wet weather.

My opinion, therefore, is that Tsetse-fly is to be found in certain dark, damp, low-lying localities, irrespective of big game of any kind.

I have, etc.,
(Signed) J. W. P. MCCLELLAN.

THE RESIDENCY, ZOMBA,
British Central Africa Protectorate,
30th September, 1901.

COMMISSIONER SHARPE, C.B., *to* HIS MAJESTY'S PRINCIPAL SECRETARY OF STATE FOR FOREIGN AFFAIRS.

MY LORD,—With reference to your Lordship's despatches Nos. 141 and 155, enclosing copies of correspondence on the subject of the connection between the existence of Tsetse-fly and the preservation of Buffalo, I have the honour to append a few notes which give my own experience during the past fourteen years in Africa on this subject.

1. Tsetse-fly would appear to depend upon wild game for their existence, as I have never found Tsetse in any locality where game was totally non-existent.

2. Tsetse does not in any way appear to be specially dependent upon Buffalo. On the plains at the north end of Nyasa, before rinderpest made its appearance, there were vast herds of Buffalo, but no Tsetse. The natives at the north end at that time owned large quantities of cattle, which could be seen grazing in close proximity to Buffalo. When rinderpest came it killed practically all the cattle and all the Buffalo. In other districts of British Central Africa Tsetse are found in large quantities where Buffalo, at the present day at any rate, do not exist.

3. Tsetse are not found (in British Central Africa) in open plains, although such plains may have large quantities of game on them, and in spite of the fact that at the edges of the plains, where forest abounds, Tsetse are found. It would appear therefore that what regulates the presence of Tsetse-fly is the description of the country, almost as much as the abundance or scarcity of game.

I have, etc.,
(Signed) ALFRED SHARPE,
His Majesty's Commissioner and Consul General.

ENTEBBE, UGANDA,
27th September, 1901.

DEPUTY COMMISSIONER JACKSON, C.B., *to* THE MARQUESS OF LANSDOWNE, K.G., etc., etc.

MY LORD,—I have the honour to acknowledge the receipt of your Lordship's despatch No. 190 of July 20th, with enclosures regarding the question of the existence of the Tsetse-fly in connection with the preservation of the Buffalo, and in reply to submit the following remarks, in so far as my own experience has taught me, on this vexed question.

I may say at once that I am firmly of the opinion that, in East Africa, the existence of the Tsetse-fly was never in any way connected with the presence of the Buffalo more than any other species of game.

I first met with the true Tsetse in very great numbers, and consequently suffered much from their needle-like bite, in German East Africa, about 80 miles inland from Saadani in Feb. 1886. At that time impala, hartebeest, zebras, and wart-hogs were found in large numbers, also a few sable antelopes, but there were no Buffaloes anywhere in the vicinity of my shooting grounds. In 1887 I again found this fly in great numbers in a small patch of thick bush, about a mile and a half long and three-quarters of a mile wide, some ten miles west of Taveita. In this bush, which projected from the forest, I certainly found Buffaloes occasionally, but as a rule they preferred to lie up for the day in the thick and cooler forest, in which there were no Tsetse. The bush in question was a favourite resort of impala and a small dik-dik (*Madoqua*)—the latter in great numbers—and also a few bush-buck and water-buck. At that time (1887) Buffaloes may be said to have swarmed in the vicinity of Taveita, but I never saw a Tsetse-fly except in this one particular patch of bush.

Later on, in 1889 and 1890, the fly was met with, also in great numbers, along the old caravan road from about two miles south of the Tsavo River as far as Kibwezi. Between these two points there were practically no Buffalo, but a great number of dik-dik and a few impala. The fly and the small game are still there, but there are certainly no Buffaloes.

In 1891–92, after rinderpest had carried off nearly all of the Buffaloes (at least 90 per cent.) throughout East Africa, Mr. Rogers, the present Sub-Commissioner of the Tanaland Province, and myself found the Tsetse-fly existing in considerable numbers in a narrow belt of forest not more than a mile wide, between Mkonumbi and Witu, and we were told by the natives that the Gallas, when driving cattle to Lamu for sale, always drove them through the forest by night, and that the herdsmen carried smoking firebrands to keep the flies off. With the exception of a few bush-buck and duyker there was no game in the vicinity of this belt of forest.

These four places are the only areas, the first and third ones alone being of any considerable extent, in which I have myself met with the true Tsetse-fly, and yet, until they were decimated by rinderpest, Buffaloes were more or less common throughout East Africa; and perhaps in no part of the Continent were they ever more plentiful than in the Masai Country between Kilima Njaro and Lake Baringo, Mau Plateau and Turkwell. Throughout the whole of this vast area the Tsetse was, and is, non-existent.

I may add that there is a species of Tsetse-fly found along the wooded portion of the lake shore here at Entebbe. A specimen of this fly I gave to Sir Harry Johnston, and I believe he sent it home.* It is plentiful in the Botanical Gardens. In these Gardens, with the exception of a few monkeys and squirrels, and certain small nocturnal beasts, such as the ichneumons, etc., and an occasional hippopotamus, there are no mammals, and if, as is supposed, the fly is necessarily dependent on the presence of suitable mammals on which to feed, the blood of these animals, and occasionally man, must necessarily form its food supply.

In conclusion, I may add that I have ventured to hold the opinion that the Tsetse is, like the mosquito, only a blood-sucker by predilection; and, in support of this view, I may state that on my return from Kibwezi in April, 1892, at a time when the whole of the "fly-belt" was parched and dried up—there being no water between Msogoleni and Tsavo River, a distance of 50 miles, and consequently no game of any kind—the Tsetse was more plentiful than at any other time, before or since, that I have passed through that area. Between Mtoto-Ndai and Kinani I caught on my own person thirteen of these flies, and my half-naked porters suffered even more than I did from their bites. I can, therefore, not readily believe that all these flies could exist in such a dried-up, and, at that time, intensely hot locality, if solely dependent upon the blood of a very infrequent passer-by or a stray dik-dik.

I have, etc.,
(Signed) F. J. Jackson.

APPENDIX D.

Native Methods of Protecting Animals from the Attacks of Tsetse-flies. Native Prophylactics against and Remedies for Tsetse-fly Disease. Native Names for Tsetse-Flies.

Native Methods of Protecting Animals from the Attacks of Tsetse-flies.

The practice of crossing Fly-belts at night, with a view to the protection of oxen and horses, has been referred to in Chapter I, where it was shown not to be an infallible safeguard although usually free from any great risk. According to Livingstone [21] and Kirk [28], natives sometimes take advantage of the remarkable dislike evinced by the Tsetse to

* As I have not seen this specimen, the particular species of Tsetse-fly found at Entebbe, on Lake Victoria, must be a matter of conjecture. —E. E. A.

animal excreta, by plastering animals which have to pass through a Fly-infested tract with a compound containing ordure and other matters, which is stated to keep the Fly at a distance for the time being. Subsequently, Livingstone was told [49] that the Banyamwezi use lion's fat, smeared on the tails of the oxen, for a similar purpose with equal effect. In East Africa the Galla herdsmen, when obliged to pass through a belt of forest infested by Tsetse, light large fires and drive their cattle through the smoke, which keeps off the flies [139]: according to Mr. W. W. A. Fitzgerald [154], they also adopt the additional precaution of moving the animals at night, and Mr. F. J. Jackson (Appendix C, p. 296) says that he was "told by the natives that the Gallas, when driving cattle to Lamu for sale, always drove them through the forest by night, and that the herdsmen carried smoking firebrands to keep the flies off."

Native Prophylactics against and Remedies for Tsetse-fly Disease.

The specifics which come under this heading, as recorded by various authors quoted in the Bibliography, are apparently nothing more than the nostrums of witch-doctors and other impostors, and are probably unworthy of serious notice. In some cases plants or roots, which have not been identified, are said to be used as a remedy [26, 28, 37]; in others the Fly itself in varying quantities, and sometimes with the addition of the bark of a certain root, is administered internally [27, 30]. Thus W. M. Kerr [97], writing of the country near Chibinga, Mashonaland, where Tsetse abounded in July, 1884, says: "The native women dry quantities of the Tsetse-fly and pulverise it with the bark of a root, and mixing it with water give it to the young animals, such as dogs and goats or sheep, of which they have very few, seemingly only kept as pets." This treatment seems at any rate to have been believed in by the pioneer-explorer Carl Mauch [50], who writes: "Only one remedy appears to be effective, and that is based upon homœopathic principles: the Fly itself, taken internally, makes the punctures innocuous, as I have seen in the case of a dog, which after administering this remedy I took with me as far as the Lower Zambesi and sent back again perfectly well with those who had accompanied me." It may be mentioned that, according to Chapman [30], a peculiar breed of dogs known as *Makoba*, bred in the Fly-country "from time immemorial," escapes Tsetse-fly disease; while Andersson [20] asserts that, "a dog reared on the meat of *game*, may be hunted in Tsetse districts in safety." *

* Colonel Bruce, however, found that a native dog contracted Tsetse-fly disease after eating a piece of coagulated blood from the heart of a heifer which had died from it. He also mentions an instance in which dogs contracted and died from Nagana after eating the flesh of a zebra; as also another case in which a similar fate was stated to have overtaken dogs which had fed on the raw flesh of a bullock, which had perished from the disease (*Cf.* Appendix A, pp. 281–282).

Livingstone's assertion that calves do not contract Tsetse-fly disease so long as they are being suckled by their mothers was doubtless based on the statements of natives; while the native belief in "homœopathic" prophylactics or remedies is further illustrated by Baines [55], who writes: "All young animals while living on milk are safe. Some of the tribes living on the borders drive the calves into the fly during the day, and bring them out to be suckled morning and night. This is supposed also to render them secure during the rest of their lives." Similar precautions are said to be adopted by the Bushmen in the case of dogs. According to Bradshaw [77]: "Dogs are taken into the fly district by the Bushmen when pups, and are allowed to suckle the mother, and at the same time given as much fly to eat as can be captured for them. The mother in this case dies, and the pups live and grow up, but are the most miserable looking objects I ever saw belonging to the canine race—emaciated, small, and the hair standing up all over them."

Native Names for Tsetse-flies.

The following list of native names is of course very far from complete, but it is printed here in the hope that it may prove of some slight use to investigators.

The Tsetse is called *kipanga* (meaning "little sword") near Kilwa.—Captain R. F. Burton [25].
" " *panga* (or "sword"-fly) in Unyamwezi.—H. M. Stanley [45].
" " *chipinga* on the Rovuma River.—Dr. Kirk [28].
" " *chufwa* by the Wasawahili, near Rosako, in Ukwere, about 20 miles inland from Bagamoyo.—H. M. Stanley [45].
" " *buñgo* in the Manyuema country.—Dr. Livingstone [49].
" " *ganda* by the Wa-Galla.—W. W. A. Fitzgerald [154].
" " *mau* in the country of the Rhol Tribe, north-west of Gondokoro.—Mr. and Mrs. Petherick [37].
" " *kasyembi*, by the Ahenga, Ankamanga, and Atumbuka in British Central Africa.—Captain Crawshay (Appendix B).
" " *chisemberi* (pl. *visemberi*) by the Awemba of Itawa and Kabwiri, British Central Africa.—Captain Crawshay (Appendix B).
" " *impugan* on the Revui River, Mashonaland.—F. C. Selous [121].
" " *adjoë* in Togo.—Dr. Schilling [170].

APPENDIX E.

The Geographical Distribution of Nagana, and the Possible Transmission of the Parasite of the Disease by Species of *Glossina* other than *Gl. morsitans*, and by Blood-Sucking Flies other than Tsetse.*

In spite of the apparently over-hasty conclusions of Koch and other German investigators, the question as to the identity of Nagana with the disease known in India as Surra is not yet by any means finally decided. This, however, is beyond the scope of the present work, which is confined to Africa.

Apart from the region to the south of Lakes Tanganyika and Nyasa, the chief foci of Tsetse-fly disease at present definitely known are situated in German East Africa, British East Africa, and Somaliland on the east, and in the German Protectorate of Togo on the west. In the opinion of MM. Laveran and Mesnil [XXI.], Nagana probably occurs wherever *Glossina morsitans* or one of its congeners exists, but information at present available does not altogether warrant such a conclusion. Thus Stuhlmann [174] records the capture in January, 1902, of specimens of "*Glossina tabaniformis*, Westw." (*Gl. fusca*, Walk.), near Dar-es-Salâm, at a place where the same cattle and goats had grazed for a long time without the disease having appeared among them. On this account, and—"Reasoning from general conclusions derived from analogy in connection with the diseases due to infection of the blood, in which each parasite has its own particular host and intermediate host"—Dr. Stuhlmann thinks that it may be assumed that Tsetse-fly disease "is not conveyed by *Glossina tabaniformis*." In this case we are given no information as to the presence or absence of game in the vicinity, but what appears to have been the same species of Tsetse was met with in December, 1895, by Mr. A. H. Neumann [152], on the eastern shore of Lake Rudolph, where game was abundant. Mr. Neumann writes: "Whether this kind is poisonous or not I am not sure. My donkeys never suffered from having passed here; but then they can stand a *few* 'fly,' though where the 'Tetse' is numerous they soon succumb." Turning to another species of Tsetse-fly, in September, 1899, at Lumley, a few miles from Free Town, Sierra Leone, I myself saw a herd of cattle being pastured on grass-land in close proximity to a mangrove swamp where *Glossina palpalis*, Rob.-Desv., was present in some

* The statements in this section are by no means to be taken as constituting the last word on the subjects referred to; they are intended rather to suggest lines for future investigation, by drawing attention to the paucity of our present knowledge.

numbers.* The flies were not actually observed attacking the cattle, but they probably did so since they bit my two companions and myself when seated on the seashore hard by. It is but fair to mention that, with the exception of a few small buck, there are no wild animals of any size near Free Town which might afford sustenance to the Tsetse and at the same time harbour the Trypanosome. But this is not the case in Uganda, where, according to Sir Harry Johnston [172], "nearly every known type of African antelope is represented," not to mention buffalo, giraffes, and zebras, while *Glossina* (species as yet undetermined) also occurs there, although Tsetse-fly disease is absent. With regard to Uganda, Sir Harry Johnston suggests that "either the true Tse-tse is absent from all parts of the Protectorate, or it is unable to obtain there the germs of fever which it is the agent in introducing to the blood of horses, cattle, and other beasts." By "the true Tse-tse," Sir Harry Johnston doubtless means *Glossina morsitans*, Westw., and if so the first of his suggestions is in accordance with the view of Dr. Stuhlmann, as expressed in a recent paper [XXVI.], which shortly stated is that *Gl. morsitans* is *the only species* capable of conveying Tsetse-fly disease. From a quotation already given the reader will understand that Dr. Stuhlmann bases his conclusion upon the analogy between Tsetse-fly disease and malaria and Texas fever (*cf.* p. 300). Elsewhere he writes [XXVI.]: "The fact is that, in the case of all these blood diseases, the host and intermediate host are animals of perfectly definite kinds. It is, moreover, improbable that the proboscis of the Tsetse merely operates as an inoculating needle; rather must we assume, from analogy with malaria, that within the fly the *Trypanosoma* passes through a special stage of development, which it is true is at present unknown." In this conclusion Stuhlmann is supported by Veterinary-Surgeon Schmidt, in a memorandum which is quoted on p. 263. So far as I am aware, the only modes of reproduction which have yet been observed in any Trypanosome are either binary longitudinal fission, or the breaking off from a plasmodium, formed by the fusion of a number of adults, of amœboid forms which subsequently assume the well-known adult stage. Nevertheless, although nothing has yet been observed in the case of *Trypanosoma* in any way comparable to the gametocytes in that of the parasites of malarial fevers in man, it is of course quite possible that on entering the stomach of the Tsetse the parasites become sexually mature, and that it is their progeny and not they themselves that subsequently find their way into the blood of another

* Somewhat similar conditions would appear to exist in Loango, or at least to have existed there at the time of the German Loangó Expedition about thirty years ago (*Cf.* 65, 65a, 80, and Chapter II., p. 40).

mammal.* In this case the Tsetse would be a true host† of the parasite, and not the mere "inoculating needle" which Colonel Bruce's investigations would lead us to suppose. Colonel Bruce found that the Tsetse is capable of conveying the disease forty-eight hours after feeding on an animal suffering from Nagana,‡ which would certainly allow plenty of time for the Trypanosome to make its way back from the fly's stomach into the proboscis, assuming no process of reproduction to take place. If this is what happens, there would seem to be no reason whatever why one species of *Glossina* should not be capable of conveying the parasite of Nagana as well as another, since Dr. Hansen's investigations § tend to show that the proboscis of each species is identical in structure. On the other hand, if the Tsetse is a true host of the parasite, the latter may still be conveyed, if not by all the species of *Glossina*, at any rate by more than one species, just as the parasite of æstivo-autumnal fever in man is stated to be conveyed by several species of mosquitoes of the genus *Anopheles*. According to Laveran and Mesnil [171], who quote from Blanchard, the deaths of the camels, mules, and donkeys, of an expedition at Imi, on the Webi Shebeli, Somaliland, as observed by Brumpt, did not appear to be due to *Glossina morsitans*, but to a closely allied species. In view of the locality, this was doubtless *Gl. longipennis*, Corti. Nevertheless, it must be admitted that there is yet no *definite* evidence of the occurrence of Tsetse-fly disease in a locality where *Glossina morsitans* is not found, because our knowledge of the distribution of this species of Tsetse, as of that of all the other species, is still far from complete; and the unexpected discovery that *Gl. morsitans* occurs in Togoland,‖ where Tsetse-fly disease is known to exist, is sufficient to show that the species extends much further from the Limpopo and the Zambesi than has hitherto been supposed. We must, therefore, be careful not to assume too hastily that *Gl. morsitans* is absent from a country where Nagana is known to occur, simply because no specimens have yet been collected there. At the same time, without attempting to draw deductions from it, it seems advis-

* Colonel Bruce's observations, however, so far as they go, would seem to negative this, since they show that the hæmatozoa are still active and apparently unaltered in what remains of the blood in the stomach of the fly *nearly five days* after its meal. Bruce writes: "Immediately after feeding, the tube of the proboscis can be seen to be crammed full of red blood corpuscles, among which the hæmatozoa can be seen actively wriggling. Up to 46 hours after feeding I have seen living hæmatozoa and red blood corpuscles in the proboscis. After 118 hours the hæmatozoa are still very numerous and vigorously active in what remains of the blood in the stomach. After 140 hours the stomach is empty." (*Cf.* Appendix A, p. 278.)

† The *definitive*, not the intermediate host as stated by German writers. *Cf.* p. 260, note *.

‡ See p. 275. § *Cf.* Chapter V. ‖ See Chapter IV., p. 85.

able once more to call attention to the fact that, while a disease that appears to be Nagana undoubtedly exists in Somaliland (on the Webi Shebeli, in the Korayo Valley, the Aulihan country and elsewhere),* with fatal effects to horses, camels, donkeys, and mules, all the Tsetse-flies yet received from that country prove to belong to *Glossina longipennis*, Corti. On the other hand, the experience of Mr. W. A. Eckersley [134] near Beira, in 1893,† lends force to the second of the above quoted hypotheses of Sir Harry Johnston to account for the absence of Tsetse-fly disease from the Uganda Protectorate, and goes to support the suggestion at the end of Chapter I. that systematic efforts should be made to study the geographical distribution of the parasite of Nagana, as existing in the blood of wild animals in Africa, by means of Colonel Bruce's method of injecting blood from the latter into domestic animals.‡

As to the question whether the parasite of Nagana can be conveyed by blood-sucking flies other than the Tsetse, it may be remarked at the outset that were this the case to any large extent the disease would probably be of much more general occurrence. Nevertheless, a certain amount of evidence undoubtedly exists, which, if reliable, can only be interpreted in one of three ways: either the Tsetse occurs in localities where it has not yet been identified, and the deaths of domestic animals ascribed by natives to the agency of other and unknown flies are really due to it; or blood-sucking flies other than *Glossina* may in certain localities, and perhaps only at certain seasons, convey a hæmatozoon which is either that of Nagana or an organism closely related to it; or, lastly, the disease in these cases, whatever it may be, is quite distinct from Nagana, and is possibly, like Texas fever, disseminated by means of ticks. According to Marno [47], the assertion that "in certain parts of Africa at certain seasons domestic animals are killed by the poisonous bites of flies, which in some countries even make the keeping of particular domestic animals impossible," has been constantly repeated since the time of Agatharchides.§

* *Cf.* [94, 124, 133, 150, 171].

† A survey party to which Mr. Eckersley was attached took two Natal ponies through the Fly-belt between Beira and Chimoio without any ill-effects to the animals, although Tsetse-flies (in this case doubtless *Gl. morsitans*) settled on them in considerable numbers.

‡ *Cf.* Chapter I., p. 30, note †, and Appendix A, p. 280. According to Mr. R. J. Stordy (see Appendix C, p. 292), a parasite "the morphology of which was identical with that found in animals suffering from Tsetse-fly disease" occurs in Mombasa in donkeys, which have never left the island, although the Tsetse is said not to be found there.

§ "Agatharchides (Ἀγαθαρχίδης) or Agartharcus (Ἀγάθαρχος), a Greek grammarian, born at Cnidos, lived at Alexandria, probably about B.C. 130. He wrote a considerable number of geographical and historical works; but we have only an epitome of a portion of his work on the Erythraean Sea, which was made by Photius. It is printed in Hudson's *Geogr. Script. Gr. Minores*."—*Smith's Classical Dictionary.*

Possibly some of these statements refer to the Fayûm, in Upper Egypt, where, as I am informed by my colleague, Dr. C. W. Andrews, the Arab camel-drivers declare there is a fly in the months of May and June which kills camels;* so convinced are the drivers of this, that they will not allow their camels to visit the district during the dangerous season. If this fly has any existence in fact, it seems scarcely possible that it can be a Tsetse, since the Fayûm, which lies approximately between 29° and 29° 30′ N. latitude, is far removed from the nearest known habitat of *Glossina*. It is more probable that the fly, if it exists at all, is either a *Stomoxys* or *Lyperosia*, or else a horse-fly (*Tabanus*, *Hæmatopota*, or *Pangonia*); and in connection with the first-mentioned genus, it may be remarked that the British Museum collection contains a series of specimens of a species of *Stomoxys*, which were brought home by Dr. J. W. Gregory from Ngatana, British East Africa, where he stated that they killed his camels. Moreover, a fly that is obviously a species of *Stomoxys* was declared by Mr. F. J. Jackson [119] to be "very plentiful" in the forest on the banks of the River Lumi, at Taveta, British East Africa, where it "worries beasts to such an extent that they are unable to eat, and die." In this case, as has already been pointed out (see Chapter VI., Bibliography, p. 211), the mortality may really be due to a Trypanosome. The late Captain A. G. Haslam, at Machakos, in June, 1898, found the living Trypanosome of Tsetse-fly disease in the posterior part of the abdomen of specimens of two species of *Stomoxys* caught sucking the blood of mules suffering from the disease; and in a letter dated July 3, 1898, which he sent to the author with some of the insects, he stated that he had "caught these flies on every kind of animal, including gazelles, wildebeeste, and all domestic animals, and also on meat exposed for a few seconds." Captain Haslam went on to say: "Animals do not object to them much after the preliminary stab with the proboscis. They remain sucking for several minutes, and bulge out their abdomens with blood. I am now engaged in experiments to show whether these flies I send you actually inoculate other animals with the Tsetse disease." The lamented death of the writer, which took place but a fortnight after the date of this letter,† prevented these experiments from being completed; but it may be pointed out that any blood-sucking fly feeding upon the blood of an animal suffering from Nagana, in which the parasites were numerous,

* This insect, whatever it may be, must not be confused with the camel bot-fly (*Cephalomyia maculata*, Wied.—Family Œstridæ), the larvæ of which are very frequently met with in the nostrils of camels, but do not appear to be injurious to the animals. When mature they are sneezed out by the camels and pupate in the sand. (For a figure of the fly, see Sharp, Cambridge Natural History, Insects, Part II., p. 515).

† See page 100, note.

would naturally suck up some of the hæmatozoa with the blood, and that the presence of living parasites in the stomach of the fly by no means proves that the latter is capable of communicating the disease. On the other hand, if the parasites remain alive in the alimentary canal of *Stomoxys* sufficiently long, it is possible that some of them might make their way back into the proboscis, as Colonel Bruce supposes them to do in the case of the Tsetse, and so be subsequently introduced into the blood of another animal. Or one might suppose *Stomoxys* to be capable of conveying the parasites directly from an infected to a healthy animal, by flying to and biting the latter *immediately after* sucking blood from the former, just as Rogers [**XIX.**] in India found that the Trypanosome of Surra could be conveyed by horse-flies. In view of Rogers' results, it is certainly curious that no instance of a spontaneous outbreak of Nagana, due to the direct transference of the parasite from diseased to healthy animals by flies other than Tsetse, occurred in the course of Colonel Bruce's experiments on the Ubombo Mountain in Zululand.* This, of course, does not prove that such cases may not sometimes occur under natural conditions, when in the same locality blood-sucking flies other than Tsetse and the parasites of the disease in the blood of wild animals are both numerous.

Turning to the horse-flies (*Tabanidæ*), we find a certain amount of evidence from East Africa tending to show that if present in sufficient numbers their bites may be fatal to domestic animals. The so-called "Wandorobo"- "Donderobo"- or "Ndorobo"-fly† of the Wadschagga and Masai is as yet unidentified,

* *Cf.* Appendix A, pp. 273-274. Colonel Bruce's experience is in accordance with Kirk's statement [28] that "no danger" has been found to result from cattle bitten by Tsetse "mixing with others."

† *Cf.* Oscar Baumann, "Durch Massailand Zur Nilquelle" (Berlin: Dietrich Reimer, 1894), p. 28—[Translation] "The loss in *personnel* in Umbugwe made itself felt, besides which our baggage-donkeys had suffered from the sting (*Stich*) of the Ndorobo-fly. This insect frequents water-courses and is dangerous to donkeys, since it stings them in the anus, which results in swellings and death." (This refers to the region near Lake Manyara, W.S.W. of Kilima-Njaro.) *Cf.* also Otto Kersten, "Baron Carl Claus von der Decken's Reisen in Ost-Afrika in den Jahren 1859 bis 1861" (Leipzig und Heidelberg: C. F. Winter'sche Verlagshandlung), Band I. (1869), p. 249, Band II. (1871), p. 36. The region referred to in the following passage (Bd. I., p. 249) is the Wateita Country, inland from Mombasa. [Translation] "We had rescued the donkeys from the robbers' hands, but only to see them die after all the same day: in the case of three of them, blood and matter escaped from the nose, the head and genital organs were swollen, and the air-passages were so narrowed by ulcers that their breathing resembled a rattling—they were stung by Donderobo flies! I myself have never caught sight of the poisonous fly, and have not been able to get possession of any in spite of the offer of a reward; but the natives declared that it was only the sting of the Donderobo, which was frequently dangerous to their flocks of goats, that produced such effects. Just as Tsetse-flies attack cattle, so do the Donderobo flies chiefly attack donkeys and goats, more rarely sheep, but never cows. On the third day the animal that has been stung is already

and if such an insect really exists, may eventually prove to be a Tsetse; but it is considered by Stuhlmann [**XXVI.**] to be "more probably a horse-fly."* Schoeller [167], however, whose remarks on the question are worth referring to, considers that the disease which seems chiefly to attack baggage-donkeys "in the steppe regions of East Africa," and is attributed by the Wadschagga to the bite of an unknown fly which they call "Wandorobo," is really a malady *sui generis*, allied to the horse-sickess of South Africa ("Dikkopziekte" of the Boers). Be this as it may, Dr. W. S. Radford, writing from Nairobi, East Africa Protectorate, on September 3rd, 1901, states that in Jubaland symptoms identical with those of Tsetse-fly disease are produced in camels by the bite of a horse-fly. Dr. Radford says:† "Amongst other pests that affect camels very seriously in Jubaland is a species of gad-fly [*i.e.* horse-fly] which is restricted in its distribution to the open plains and sparsely-bushed country in the districts of Desek Wama and Derib. This fly, unlike the Tsetse, attacks animals during the day at all hours, and the symptoms produced by it (in camels) are identical in every particular with those produced by Tsetse, but I was unable at the time to substantiate this theory microscopically, owing to lack of the necessary materials, etc., for carrying on investigations." Although this is a mere statement, unsupported by any evidence of scientific value, the fact that the fly in question is confined "to the open plains and sparsely-bushed country" would seem to preclude the possibility of its being a Tsetse, even one of the large species (*Glossina fusca*, or *Gl. longipennis*), and the effort should be made to identify and experiment with the fly without delay, in addition to making a microscopical investigation of the

incapable of movement, and it is only seldom that it survives the fifth day." The country referred to in the next passage (Bd. II., p. 36), is that just south of Kilima-Njaro.—[Translation] "Even before the start we lost one of the three donkeys that remained to us, without doubt in consequence of the sting of the Donderobo fly (see Band I, p. 249). The genital organs and the inguinal glands first showed a considerable swelling; this then spread further and finally made any movement impossible; blood and matter flowed from the nose; nay, even from the orbital cavities, and an entire loss of strength indicated the near approach of the end of the animal." The statement that "the Donderobo flies chiefly attack donkeys and goats, more rarely sheep, but never cows," is curious. Some of the symptoms mentioned (swollen head and genitalia) would seem to suggest that the "Donderobo fly" is none other than the Tsetse; but the blocking of the air-passages by ulcers is noteworthy, and *death on the fifth day* appears too speedy to be the result of Tsetse bite. On the whole, Schoeller's view [167] that the disease is not due to the bites of flies at all, but is a malady allied to the South African horse-sickness, seems reasonable.

* According to Otto Kersten [43], on the other hand, nothing is heard of the attacks of horse-flies in the region between Mombasa and Dschagga, although "the Donderobo-fly, which is dangerous to donkeys," is alleged by natives to occur there.

† *Cf.* Appendix C, p. 293.

blood of the diseased camels. Dr. Radford expresses the opinion that the hæmatozoon of Tsetse-fly disease "is in all probability to be found in many species of Diptera," but he advances no further arguments in support of this view, which, in so far as it refers to the normal *conveyance* of the parasite, is, as already pointed out, *a priori* improbable. With regard to the alleged effects of the bites of Tabanidæ upon camels, however, there is some further evidence, though in this case it is quite possible that the real culprit is *Glossina longipennis*, which is of about the same length as the smaller fly referred to. Colonel Swayne, writing to the Secretary of the Zoological Society in 1894, said: "I send you three specimens of 'Doog' (a large fly) and three specimens of 'Balaad' (a small fly). . . . I was very much pestered by 'Doog' on my way through Ogaden to the Webbe Shebeyli, in Somaliland. They swarmed on my camels, constantly drawing blood. The other fly, 'Balaad,' which looks not unlike the common house-fly, is far the worst fly on the Webbe; a valuable camel, on which I caught three or four two months ago is now dying, and the Somalis say that this is due to the bites of 'Balaad.' If there are many of them they kill horses and camels, and the Somalis will not have their live stock grazing where 'Doog' and 'Balaad' are found." * On the other hand, the conclusion which might be drawn from Colonel Swayne's statements is traversed by others contained in a Report (dated May 26, 1891) from the officer in charge of what was then the Imperial British East Africa Company's Station at Lamu. According to this document, which accompanied specimens of Tsetse-flies and Tabanidæ sent to the British Museum for determination, the bites of horse-flies inflicted upon domestic animals do not cause "any kind of blood-poisoning like those of the Tsetse," although it is stated that some of the natives declare that they do. The Report observes that the bite of the Tabanidæ "is extremely sharp, and, though causing comparatively little irritation, produces much swelling of the surrounding parts." The writer adds: "Both cattle and donkeys bleed a good deal from the puncture, and the Germans tell me that in some cases their cattle bled to death, it being impossible to stop the bleeding, although they tried acids, etc." The latter statement suggests the possibility that, in some cases at any rate, animals said to have been killed by the bites of flies other than Tsetse, may really have died from hæmorrhage caused by

* *Two* species seem here to be distinguished by the Somalis, but the specimens sent by Colonel Swayne included examples of *three*: of the three flies representing "Doog," two proved to belong to a new species subsequently described by the author under the name *Pangonia tricolor* (*nom. præocc.* = *P. beckeri*, Bezzi), while the third specimen belonged to another species of *Pangonia*, but was too much damaged for determination. The three specimens representing "Balaad" were examples of a small Tabanid, somewhat resembling *Hæmatopota* in form, but with clear wings; these specimens were also too much damaged to determine.

the bites—such bleeding as, for instance, according to Sir H. M. Stanley [45], results from the bites of a large horse-fly, called *Mabunga* by the natives, near Rosako, in Ukwere, about twenty miles inland from Bagamoyo. "This fly," writes Stanley, "along with a score of others, attacked my grey horse, and bit it so severely in the legs that they appeared as if bathed in blood." * The explorer's men "unanimously stated that its bite was fatal to horses as well as to donkeys." In "The Nile Tributaries of Abyssinia" (London: Macmillan and Co., 1867), the late Sir Samuel W. Baker, writing of the country between the Settite and Atbara Rivers, describes and figures a "Seroot fly" (pp. 184–185), which he states (p. 184) is the species "that drives the camels from the country"; from the figure and description it is evident that this insect is a horse-fly belonging to the genus *Pangonia*, and not a *Glossina*. Further on (p. 196), a remarkable description is given of an instance in which swarms of Seroot flies rendered it impossible to take possession of a giraffe which had been shot. Sir Samuel Baker writes: "The Seroot-fly was in swarms about the carcase, thousands were buzzing about our ears and biting like bull-dogs; the blood was streaming from our necks, and, as I wore no sleeves, my naked arms suffered terribly. I never saw such an extraordinary sight; although we had killed our giraffe, we could not take possession; it was no wonder that camels and all domestic animals were killed by this horrible plague, the only wonder was the possibility of wild animals resisting the attack. The long tails of the giraffes are admirable fly-whippers, but they would be of little service against such a determined and blood-thirsty enemy as the Seroot." Subsequently (p. 210) the author mentions herds of game as retreating from the south before the attacks of the Seroot. On the Blue and White Niles several species of horse-flies, belonging to the genera *Tabanus* and *Pangonia*, are known to Europeans under the comprehensive name Seroot; all are greedy blood-suckers, but it would lead us too far from the question at issue to pursue the subject further. It is hoped, however, that enough has been said to demonstrate the advisability of determining once for all, by a series of practical experiments, whether the various African species of Tabanidæ, as also those near allies of the Tsetse belonging to *Stomoxys* or *Lyperosia* can, under any circumstances, become the carriers of the Trypanosome of Nagana, or possibly of some other closely related hæmatozoon.

* There is no need, however, to go to Central Africa in order to see horses' legs streaming with blood from the attacks of Tabanidæ, since this can be observed in Switzerland and Italy. That African cattle can withstand the loss of a considerable quantity of blood without succumbing is proved by the well-known habit of the Masai of bleeding their cattle to the point of faintness for the sake of drinking the blood; in this case the cattle recover after bleeding has terminated.

APPENDIX F.

"A Note on the Origin of the word 'Tse-Tse.'" By Captain Richard Crawshay.*

"The word 'Tse-Tse' at once indicates Bantu origin. It is a good example of the remarkable onomatopœia abounding in Bantu languages, especially in the names of mammals, birds, reptiles and insects. It also illustrates that affinity in root characteristic of this group of languages, traceable even in the case of tribes separated from one another by vast distances.

"According to Messrs. Mabille and Jacottet, 'Tse-Tse' is the name by which the Basuto know the insect, but whether it originated with them or has been introduced from another tribe I do not know.

"This word is not to be confounded with 'Ntsintsi,' the Sesuto name for the common fly, which in Central Africa with the Anyanja is 'Nchenchi,' with the Ahenga 'Lumembi,' and with the Awemba of the head waters of the Congo River 'Runzi.' In Equatorial Africa the Waswahili of the coast know the common fly as 'Inzi,' while the Akikuyu of the forest highlands call it 'Ngi.'"

Richard Crawshay.

Leighton Buzzard,
March 3rd, 1903.

* Received too late for inclusion in the body of the work: the reader should compare the note on pp. 1–2.—E. E. A.

APPENDIX G.

The Species of Tsetse found at Entebbe, Lake Victoria, Uganda (see page 297).

A series of specimens forwarded by Lt.-Col. Bruce which I have just had the opportunity of examining, prove that this species is none other than the West African *Glossina palpalis*, Rob.-Desv. This unexpected discovery becomes less surprising than it might otherwise appear when we consider the extremely wide range of certain other species of Tsetse-flies: *e.g.*, *Glossina fusca*, Walk., occurs in East as well as in West Africa, while the South African *Glossina morsitans* is also found in Togoland, on the Slave Coast (see page 85).

E. E. A.

May 15th, 1903.

APPENDIX H.

Trypanosomiasis on the Upper Niger. A Note by Dr. Cuthbert Christy.

Just before publication, I have received the following communication from Dr. Cuthbert Christy, who was recently sent to Uganda, with other observers, by a Committee of the Royal Society in order to investigate the causes of the Sleeping Sickness.

Dr. Christy says :—"In 1898–99, at Jebba, on the Upper Niger, there was and had been for several seasons a great mortality among the horses of the Royal Niger Company's Constabulary. I remember that the mortality was so serious that orders were at one time given to kill all the remaining horses, healthy or otherwise, and to burn down the whole of the extensive grass-sheds used as stables. This was done, but without having the slightest effect in staying the disease among the fresh supply of horses.

"I was at that time stationed at Jebba, as Senior Medical Officer of the 2nd Battalion West African Frontier Force, and in examining a fresh preparation of the blood of one of the sick horses, I discovered that it contained Trypanosomes. After this it became necessary for me to make a microscopical examination of the blood of every horse before it was purchased for the Imperial forces, and I found that fully 50 per cent. of the horses sent in at certain times of the year were infected with Trypanosome disease.

"Each rainy season our horses had to be sent to some high ground on the right bank of the river, or they invariably died. A species of Tsetse was extremely common in the neighbourhood of Jebba, although not universally distributed. On certain reaches, often not more than a mile or so in extent, the fly made canoe-travelling without a net most uncomfortable: the reach that I remember best was one just north of Bussa. Again, the left bank of a small stream only two or three miles above Jebba was a favourite 'belt,' and a remarkable one to us, since we knew little of the subject at that date, owing to the fact that it was not more than four or five hundred yards in width. To remain in the belt was torment, but five hundred yards from the stream not a fly was to be seen for many miles."

INDEX.

A.

Alcock, Sir R. (1879), Tsetse-fly, destruction of draught cattle by, 39, 174
Allies of Tsetse, nearest existing, 53
Andersson, C. J. (1856), Tsetse-fly near Lake Ngami, 10, 20, 34, 128
Antennæ of *Glossina*, 62; figure, 63
Arnaud, M. (1852), note on fly brought home by Mr. Oswell, 33, 126
Arnot, F. S. (1889), Tsetse-fly prevalent between Mababi-flat and the Zambesi, 202
Arsenic as a remedy for Tsetse-fly disease, 282, 284
Association of Tsetse with big game, 12, 173, 287, 290
Austen, E. E. (1899), Proceedings of expedition for study of causes of malaria. Notes on *Glossina longipalpis* (really *Gl. palpalis*) in vicinity of Free Town, Sierra Leone, 48, 245
(1900), Proceedings of Zoological Society of London. A female of *Gl. longipennis*, taken in West Somaliland, 245

B.

Baines, Thomas (1864), Tsetse-fly in S. Africa; at the Victoria Falls, 34, 134
(1877), Tsetse-fly in Matabeleland, on the Limpopo, in the Northern Transvaal; appearance of fly, symptoms caused, remedies, 19, 38, 163
Baker, Sir S. W. (1866), Tsetse-fly in Obbo, 35, 140
Beira Railway, fly-belt on, 45
Belts, limitation of Tsetse-fly to, 11
Bent, T. (1893), importance of Beira Railway for crossing the Tsetse-belt, 44, 208
Bibliography; literature of Tsetse-flies, 121; of Tsetse-fly disease, 253
Bigot, J. M. F. (1885), original description of *Glossina ventricosa* (= *Gl. palpalis*), 113, 193
(1891), *Glossina grossa* and *pallicera*, 207
Bionomics of the Tsetse-flies, 1
Blandford, W. F. H. (1896), the Tsetse-fly disease, 45, 224
Blood-sucking, behaviour of Tsetse during, 20
Boyce, Ross and Sherrington (1902), note on discovery of the human *Trypanosoma*, 267
Bradford and Plimmer (1902), *Trypanosoma brucei*, the organism found in Nagana, or Tsetse-fly disease, 258
Bradshaw, Dr. B. F. (1881), the Tsetse-fly about the Zambesi, 16, 19, 39, 184
Brown, W. H. (1899), Tsetse-fly in Mashonaland, 48, 244
Bruce, James (1813), Tsetse-fly perhaps described under name of Tsaltsalya, 32, 121
Bruce, Surgeon-Major (1895), preliminary report on Tsetse-fly disease, 45, 219
(1897), Further Report on Tsetse-fly disease in Zululand, 46, 226
definition of the disease, 270
distribution in Zululand, 270
nomenclature, 270
etiology, 270
description and habits of fly, 271
experiments with, 273
hæmatozoon (the), or blood-parasite of fly-disease, 277
feeding experiments, 281
fly-disease or Nagana, as it occurs in domestic animals, 270

relation of big game to the fly-disease, 278
treatment, medicinal; arsenic as a curative agent, 282; as a prophylactic, 284
(1902), note on the discovery of a new *Trypanosoma*, 258
Bryden, H. A. (1900), Tsetse-fly causing abandonment of a line of coaches from Pungwe river towards Mashonaland, 48, 246
Buffaloes, connection between and prevalence of fly, 278, 290
Indian, experiments with, as to resistance to effects of fly, 37, 154
Burton, Capt. R. F. (1860), Tsetse-fly in Central Africa, 34, 133
Buxton, E. C. (1871), experiences of the Tsetse-fly on south side of Lebombo Mountains, 15, 36, 148

C.

Camels, Livingstone's experiments with, 37, 154
Capello, H. and R. Ivens (1886), a chapter on the Tsetse-fly (in Portuguese), 42, 195
Carter, Capt. F. F. (1880), Tsetse-fly in Central Africa, 8, 176
Casati, Major G. (1891), the Tsetse-fly west of Lake Albert Nyanza, 43, 206
Castlenau, L. de (1858), the Tsetse-fly in South Africa, 34, 131
Chapman, James (1868), symptoms of bite of Tsetse-fly; native remedies; prevalence of fly in various parts, 7, 22, 35, 141
Characters, general, of Tsetse-fly, 3, 60
Chavanne, J. (1887), region of Lower Congo free from Tsetse-fly, 42, 199
Christy, Dr. C., note on Trypanosomiasis in horses on the Upper Niger, 310
Clark, Bracy (1857), attempts to show that Tsetse is identical with *Œstrus* (*Hypoderma*) *bovis;* refuted by Westwood, 34, 131
Coaches, line of, abandoned, owing to Tsetse-fly, 48
Corti, E. (1895), original description of *G. longipennis* from Somaliland, 52, 219
Crawshay, Capt. R., note on the "Tse-Tse" flies of British Central Africa Protectorate, refers mainly to *Glossina morsitans* and *pallidipes*, 20, 287
note on the origin of the word "Tse-Tse," 309
Cumming, R. Gordon (1850), the Tsetse-fly in the Transvaal, 33, 125

D.

Day, time of, at which Tsetse most active, 16
Dogs, liable to suffer from Tsetse-fly disease, 280
Donitz, W. (1896), report of paper on Tsetse-flies, 226
Donkey, immunity of, asserted by Mauch, 36; immunity denied, 46
Drysdale, Dr. J. J. (1879), an early suggestion as to the true part played by the Tsetse-fly in connection with the disease, 38, 173
Duparquet, Père (1881), Tsetse-fly on the Okavango river, at its junction with Lake Ngami, 179
Duration of illness in animals bitten by Tsetse, 142
Dutton, Dr. J. E. (1902), preliminary note on a Trypanosome occurring in the blood of man, 259

E.

Eckersley, W. A. (1895), Tsetse-fly on line of Beira Railway; two ponies taken through fly-belt without ill results, 45, 220
Elephants, Indian, experiments with, as to immunity from effects of bite of fly, 40, 187
Eliot, Sir C., letter from, regarding connection of fly with buffaloes and other big game, 291
Elton, Capt. J. F. (1879), question whether disease and death of cattle on Unyamyembe route from coast be due to Tsetse or to rank vegetation, 39, 173
Encyclopædia Britannica (1888), article on Tsetse-fly referred to, 43, 201
Erskine, St. V. (1870), paper questioning idea that bite of Tsetse-fly is destructive of animal life, 35, 146
Explanation of Figures (Plates VIII. and IX.), 117

F.

Fitzgerald, W. W. A. (1898). The Tsetse-fly on the coast of British East Africa, 47, 240
Flight of Tsetse-fly, mode of, 19
"Fly-belts," 9; Boer method of crossing at night, 39, 184, 203
Foà, E. A. (1895), the Tsetse-fly in Central Africa, 19, 45, 221
(1897), bite of the fly harmless to wild animals, especially buffalo and large antelope, 231
Fordo, R. M. (1902), clinical notes on a European patient in whose blood a *Trypanosoma* was observed, 266
(1902), the discovery of the human *Trypanosoma*, 267
Foster, Capt. (1893), Handbook of British East Africa; localities affected by Tsetse-fly, 44, 211
Free Town, Sierra Leone, *Gl. palpalis* found there by author, 76, 92
Frere, Sir B. (1881), method of crossing the fly-belt south of the Zambesi, 177
Fynney, F. B. (1878), Tsetse-fly in Zoutpansberg; predicts its disappearance with extinction of big game, 38, 173

G.

Galla method of crossing fly-belts, 225
Game, large, prevalence of Tsetse-fly dependent on existence of, and extinction with disappearance of, 12, 173, 287, 290, *et seq.*
Geographical distribution of Tsetse-flies, 28
Ghika, Prince N. D. (1898), destruction by Tsetse-fly of cattle and horses in the Aulihan country, Somaliland, 47, 234
Gibbons, Capt. A. St. H. (1897), Tsetse-fly on the banks of the Zambesi, 47, 226
(1898), Exploration and hunting in Central Africa, 7, 18, 236
Gielgud, Mr. van, 1901, letter on connection between Tsetse-fly and buffalo, 290
Glossina and *Stomoxys*, the mouth parts of, 105
—— antennæ of, 62
—— chætotaxy of, 67
Glossina and *Stomoxys*, distinguished from specimens of *Stomoxys* and *Hæmatopota*, 5
—— distinguishing characters of genus, 60
—— external mouth-parts and mode of action, 106
—— genus containing seven known species, 3
—— head, description of, 61; thorax, abdomen, 64; legs and wings, 65; antennæ, 62
—— internal mouth-parts and mode of action, 114
—— resemblance between and *Lyperosia*, 56
—— —— in venation of wings between, and *Hypoderma*, 66
—— synopsis of species of, 70
—— *fusca*, description of, 95; head, thorax, abdomen and legs, 96; veins in wings, 97; distinguishing characters of, 97; distribution, 98; habits, etc., 99; synonymy and affinities, 100
—— *longipalpis*, description of, 90; distinguished from *Gl. pallidipes*, 91, 93; males distinguished from those of *Gl. morsitans* and *pallidipes*, 94; head, thorax, abdomen and legs, 91; distribution of, 91; synonymy and affinities, 92; hypopygium in, figure of, 94
—— *longipennis*, description of, head, 101; thorax, abdomen, legs and wings, 102; distribution of, 103; habits, etc., 103; synonymy and affinities, 103
—— *morsitans*, description of, 81; distinguished from *Gl. pallidipes* and *longipalpis*, 93–94; head, thorax, abdomen, legs, 82; hypopygium in, figure of, 94; wings, 83; distribution of, 83; habits of, 86; synonymy and affinities of, 87
—— *pallicera*, description of, head, thorax, 79; abdomen, 80; distribution and habits, 80; synonymy and affinities of, 80
—— *pallidipes*, description of, 87; distribution of, 88; habits of, 90; synonymy and affinities of, 90; distinguished from *Gl. morsitans* and *longipalpis*, 93

Glossina palpalis, description of, 71; head, 72; abdomen and legs, 73; distribution of, 75, 309; habits of, 76; synonymy and affinities of, 77; var. *tachinoides*, Westw., 77
—— and *Stomoxys*, the mouth-parts of, by Dr. H. J. Hansen, 105 (see also *mouth-parts*)
Goats, doubtful immunity of, from effects of Tsetse, 47
Gregory, J. W. (1896), Tsetse-fly in belt of forest between Witu and coast, 46, 225
Grube, Dr. (1874), lecture on Tsetse-fly, with résumé of Livingstone's observations, 154
Guerne, Jules de (1894), report of exhibition of two specimens of *Gl. morsitans*, collected in Central Africa by E. Foà, 44, 218

H.

Habenicht, H. (1887), limits of Tsetse-fly north and south of Limpopo and south of Zambesi, 42, 199
Hæmatopota, distinguished from *Glossina*, 6
—— figure of, in resting attitude, 6
Hæmatozoon of Tsetse-fly disease, see *Trypanosoma*
Hansen, Dr. H. J., mouth-parts of *Glossina* and *Stomoxys*, 105
Hardinge, Sir A. (1897), Tsetse-fly in East Africa; cattle flourish in Ukamba, 227
Harris, Sir W. C. (1839), Tsetse-fly in Mural hills, Waterberg district of Transvaal, 16, 32, 124
Hartmann, Dr. (1877), lecture on specimens of Tsetse-flies, 53, 161
Haslam, Capt. A. G., possible conveyance of hæmatozoon of Tsetse-fly disease by *Stomoxys*, 304; death of, 100 (note)
Hinde, S. L. and H. (1901), the Tsetse-fly belt in East Africa, 49, 250
Historical survey of literature of Tsetse-flies, 31
Holub, Dr. E. (1880), Tsetse-fly in Matabeleland, 176
(1881), near Panda ma Tenka river, 181
(1888), in the Batoka country, 42, 200
(1890), on the Zambesi, 43, 203
Hore, E. C. (1882), Tsetse-fly on shores of Lake Tanganyika, 40, 186
Hornor, Lewis (1879), recommending Boer method of crossing fly-belts at night, 39, 175
Horse-flies (Tabanidæ) bites may be fatal to domestic animals, 305
Hough, G. de N. (1898), on two females of *Gl. longipennis*, collected in Somaliland, 47, 242
House-fly, differences between, and Tsetse-fly, 64
Humidity of soil, and low-lying positions generally necessary for existence of Tsetse-fly, 294 (*Cf.*, however, 7)
Hypopygium, 64; figures of, in *Gl. morsitans* and *longipalpis*, 94

J.

Jackson, F. J. (1893), Tsetse-fly on Teita-Kibwezi route to Uganda, 16, 21, 44, 209; (1894), Tsetse-fly in East Africa not closely associated with big game, 12, 44, 217
—— letter on non-dependence of Tsetse-fly on presence of big game, 295
James, F. L. (1883), "The Wild Tribes of the Soudan," supposed presence of Tsetse-fly, 40, 190; (1885), fly (? Tsetse) on the Webbe Shebeyli (Somaliland) in the wet season, 41, 44, 194
Jeppe, F. (1888), partial disappearance of the fly together with game from the Kaap Valley, Transvaal, 14, 42, 201
Johnston, Sir H. H. (1894), regions of eastern portion of British Central Africa affected by Tsetse-fly, 44, 125, 214; (1896), disappearance of fly from country to south of Lake Nyasa, 31, 46, 224; (1897), British Central Africa, Indian buffaloes not affected by bites of Tsetse-fly, 46, 228; parts in which fly is present, 7, 8, 9; (1899), History of Colonization of Africa by alien Races: Arabs accused in 1569 of having poisoned horses and camels, 31, 48, 243; (1901), journey from Mombasa to Uganda, difficulties owing to fly, 48, 246; (1902), suggested absence of the "true Tsetse-fly" from the Uganda protectorate, 50, 251, 301

Justice, J. N. (1902), virulence of bite of fly said to have diminished since extermination of buffalo in Northern Rhodesia, 50, 252

K.

Kanthack, Durham and Blandford (1898), on Tsetse-fly disease, 254
Karsch, Dr. F. (1893), Tsetse-fly in hinterland of Togo protectorate, 44, 213
Keane, A. H. (1888), article "Transvaal" in Encyclopædia Britannica, 201
Kerr, W. M. (1886), the Tsetse-fly in Mashonaland; travels from the Cape across the Zambesi, experiences of fly, 42, 195
Kersten, Otto (1871), Tsetse-like fly on the Juba River, 150
Kingsley, Mary H. (1897), Tsetse-fly on the Gold Coast, 46, 232
Kirby, F. V. (1899), the Tsetse-fly in East Central Africa, 243
Kirk, Sir J. (1862), the Tsetse-fly in the Shiré, and lower Zambesi valleys, 134; (1865), the Tsetse-fly of tropical Africa, 16, 18, 34, 137; (1881), visit to Dar-es-Salaam district, the Tsetse-fly, 179
Koch, R. (1898), fly-disease in German East Africa, and Trypanosomes in blood-films relating to Tsetse-fly disease, 254

L.

Laboulbène, A. (1888), Tsetse-fly not poisonous in itself; very troublesome in districts inland from Bagamoyo, 42, 199
Larva of Tsetse-fly, Col. Bruce's description, 24
Laveran, A., and F. Mesnil, mode of multiplication, morphology, etc., of *Trypanosoma*, 49, 255, 256, 258
Laveran, A., on the action of human blood-serum on the Trypanosome of Nagana, 258
—— Researches on the Treatment and Prevention of Nagana, 267
Lawley, Capt. Hon. A. (1898), movements of the Tsetse-fly with the big game of the country, 47, 239
Laws, Dr. (1879), cattle-destroying fly (? Tsetse) in valley of Limpassa; fly absent on portion of road (40 miles) from Dar-es-Salaam, 174
Leverson, Major J. J. (1893), Tsetse-fly on and near Pungwe river, 44, 209
Limitation of Tsetse-fly to belts, explanation of, 11
Livingstone, David (1857), remarks on the Tsetse-fly (*Glossina morsitans*), 10, 14, 23, 34, 129; David and Charles; (1865), Tsetse-fly near the valley of the Zambesi, 8, 135; (1874), experiments with camels and Indian buffaloes introduced from Bombay, 37, 154
Lugard, Sir F. D. (1893), British East Africa practically free from Tsetse-fly, 43, 207

M.

Macloskie, G. (1884), abstract of Kraepelin's paper on the proboscis of Musca, 192
Macquart, J. (1835 and 1843), description of the genus *Glossina*, and of *Gl. longipalpis*, 33, 123, 124; (1850), description of *Gl. longipalpis*, 33, 125; owing to the fineness of the mouth-parts, believed that the flies did not suck blood, 33
McClellan, J. W. P., on Tsetse-fly in Jubaland province; its presence not depending upon big game, 294
Mainwaring, Major H. S. (1895), Tsetse-fly in Somaliland, 45, 219
Map (1887), Justus Perthes' Special Map of Africa, showing limits of fly-belts on Limpopo and Zambesi, 42, 199
Marno, E. (1873), specimens of Tsetse-fly, called "Surrēta" by natives, 37, 153
Masui, Lieut., and — Seeldrayers (1897), the common house-fly said to cause Tsetse to disappear, 231
Mauch, Karl (1869), the Tsetse-fly near Olifant's River, 35, 145; (1870), on a journey from Lydenburg to Inyati, 36, 147; (1874), Tsetse-fly between the Limpopo and the Zambesi, 37, 159

Maund, E. A. (1891), Tsetse-fly in Mashonaland, 14, 43, 206
Mik, J. (1885), reference to three additional species of *Glossina*, 41, 193
Mohr, E. (1871), Tsetse-fly on road to Victoria Falls, 36, 149
(1876), Tsetse-fly near the Zambesi, 37, 160
Mombasa-Victoria (Uganda) Railway, Report on Progress of; mules more resistant to Tsetse-disease than other animals, 241
Mouth-parts of *Glossina* and *Stomoxys* (Dr. Hansen), 105
—— *Glossina*, external mouth-parts, maxillary palpi, 106; labrum, 107; hypopharynx, 107; labium, 107
—— *Stomoxys*, external mouth-parts, labrum, 110; hypopharynx and labium, 111
—— external, of *Glossina* and *Stomoxys*, mode of action of, 112; internal, mode of action of, 114
—— actual piercing organs in both genera, 113
Mullens, Rev. Dr. J. (1877), absence of Tsetse-fly on a new route to Lake Tanganyika, 38, 163
Muscidæ, family to which Tsetse-flies belong, 53

N.

Nagana, or Tsetse-fly disease, Bruce's definition of, 270
—— foci in German East Africa, 261
Native names for Tsetse-flies, 299
Nepveu, Dr. G. (1898) on a *Trypanosoma* in human blood, 254
Neumann, A. H. (1898), "Elephant Hunting in East Equatorial Africa"; mentions "plenty of birds and of fly" on Athi River, where other animals are scarce, 12, 47, 234
Newman, Edward (1870), supports Erskine's view that the Tsetse-fly's bite is not destructive of animal life, 36, 147; (1871) criticises Buxton's remarks to the contrary, 151
Nicholls, J. A. and W. Eglington (1892) "The Sportsman in South Africa"; the Tsetse-fly prevalent where buffaloes are abundant, 114, 207
Niger, R., Trypanosomiasis on Upper, note on, by Dr. C. Christy, 310
Night, Tsetse-fly sometimes active during, 18
Nocard, E. (1901), the relations between *Dourine*, and *Surra* or *Nagana*, 255
Nuttall, G. H. F. (1898), recent investigations on malaria, Texas fever, and Tsetse-fly disease, 253; (1899), the *rôle* of insects as carriers in the spread of bacterial and parasitic diseases, 254

O.

Oates, T. (1881), Tsetse-fly near Victoria Falls, 52, 180
Œstrus (*Hypoderma*) *bovis*, supposed identity of, with Tsetse-fly, 34, 131
Olfactory powers of Tsetse, 19, 223
Origin of name Tsetse, 1 (note), 309
Oswell, W. C. (1894), Big Game Shooting: insect attacking the Tsetse-fly; districts affected by fly, 44, 217
Oswell and Arnaud (1852), on a venomous fly in Southern Africa, 33, 127; observations on the Tsetse-fly, 128

P.

Parasite of Tsetse-fly disease, question whether conveyed by blood-sucking flies other than Tsetse, 303
Pechuël-Loesche, Dr. (1882), the Tsetse-fly on the Congo, 40, 190
Peel, C. V. A. (1900), Somaliland, prevalence of Tsetse-fly, 9, 48, 245
Perthes, J. (*See* Habenicht).
Petherick, John and Mrs. (1869), experiences of Tsetse-fly north-west of Gondokoro, 16, 35, 146
Pinto, Major Serpa (1881), Tsetse-fly on right bank of the Zambesi, 179
Plimmer and Rose Bradford (1899), the morphology and distribution of the organism found in the Tsetse-fly disease, 255
Portal, Sir G. (1894), absence of Tsetse-fly between Zavo and Kibwesi, 44, 216

Preuss, Dr. (1889), a species of *Glossina* at Barombi, Cameroons, 43, 202
Problems awaiting solution in connection with Tsetse-fly, 286
Proboscis of different species of Tsetse practically identical in structure, 106, 302
Prophylactics against and remedies for Tsetse-fly disease, 282, 297
Pupa of Zululand Tsetse-fly, 26, *et seq.*; figure of, 27

R.

Radford, Dr., letter on Tsetse-fly in East Africa Protectorate; connection between it and buffalo and other big game, 292
Rankin, L. K. (1882), the elephant experiment in Africa stated to be a complete success, 22, 40, 187
Reproduction of Tsetse-fly, 23
Resting-position, identification of Tsetse-fly in, 3, 168
Rhodesia, northern, Tsetse-fly in, 50, 252
Richards, E. H. (1885), Journey in East Africa; the Tsetse-fly on the Luizi River, 194
Robineau-Desvoidy (1830) original description of genus *Nemorhina* and of *N.* (*Glossina*) *palpalis*, 32, 51, 123
Röder, V. von (1893), *Glossina morsitans* taken at Mbuzini, German East Africa, 208
Rogers, Dr. L. (1901), probable identity of *Surra* of India, and Nagana, or Tsetse-fly disease, of Africa, 257

S.

Sambon, Dr. L. W. (1902), Note on discovery of the human Trypanosome, 267
Scepticism as to Tsetse-fly's powers 35, 146, 191
Schilling, Dr. (1901), Tsetse-fly in the Togo Protectorate, absent from the littoral, 49, 250; "surra," a disease fatal to horses in the Togo Protectorate, 257; description of the trypanosome causing the disease, 250; (1902) the "surra" disease of horses and cattle in the Togo Protectorate, 266; (1903) Nagana and other trypanosomes, 267
Schoch, G. (1883), Tsetse-fly of South Africa; a carrier of bacterium-like poisonous matter, 40, 191
Schoeller, Dr. M. (1901), reports death of baggage donkeys in East Africa, but Tsetse-fly not found, 49, 247
Schmidt, Dr. C. W. (1887), non-occurrence of Tsetse-fly in Usambara [*Cf.*, however, 261], 42, 199
Schulz, Dr. A., and A. Hammar (1897), Tsetse-fly on the swampy offshoots from the Chobe River, 46, 232
Seasonal prevalence of Tsetse-fly, 15
Selous, F. C. (1881), Tsetse-fly in Mashonaland, description and details, 8, 17, 18, 39, 181; (1883), further experiences of fly, 8, 192; (1893), Travel and Adventure in South East Africa, the Tsetse-fly, 10, 44, 211
Sensations produced by bite of Tsetse-fly, 21, 245
Seroot flies in Sudan, 308
Serum treatment of Tsetse-fly disease, 285
Sharp, D. (1899), Cambridge Natural History, notes on *Glossina morsitans*, 243
Sharpe, A. (1896), Tsetse-fly absent from highlands of British Central Africa, 226; (1901), letter on presence of Tsetse-fly not dependent solely on that of wild animals, 295
Smith, Dr. D. (1894), experiences in Somaliland; camel-killing fly in the Webi Shebeli, 44, 214
Smith, J. B. (1890), structure and history of *Hæmatobia serrata*, 202
Somaliland, fly-disease in, 41, 194, 214, 251
Stanley, H. M. (1872), experiences of Tsetse-fly (three species of biting flies), 22, 36, 151; (1878), gad-(horse-)flies and Tsetse-fly, 38, 172; (1885), bitten by Tsetse-fly on board steamer on an affluent of Congo, 194
Stordy, R. J., M.R.C.V.S. (1901), letter stating that buffalo and other big game are not the only factors connected with the Tsetse-fly, 291

Stomoxys, figure of, in resting attitude, 5; perhaps capable of conveying hæmatozoon of Tsetse-fly disease, 304; distinguished from Tsetse, 5, 56; external mouth-parts and their mode of action, 110; internal mouth-parts and mode of action, 114; lower portion of head, 114
Stuhlmann, Dr. F. (1902), Surra-disease assumed not to be conveyed by *Glossina tabaniformis* (*fusca*), 50, 253; notes on the Tsetse-fly and surra-disease conveyed by it in German East Africa, 259
"Surra," a disease fatal to horses, question whether conveyed by Tsetse-fly, 49, 153, 250, 253, 257, 259
Symptoms in animals bitten by Tsetse, 142, 168, 186, 247

T.

Tabanidæ (horse-flies) effects produced by bites of, whether similar to fly-disease, 305
Theiler, A. (1901), the Tsetse-disease, 257
—— discovery of a new *Trypanosoma*, peculiar to cattle, 259
Transvaal, Tsetse in, 201
Trypanosoma brucei, the hæmatozoon of Tsetse-fly disease, v, 253–267, 277, 301
Trypanosomiasis in horses on the Upper Niger, note on, by Dr. C. Christy, 310
"Tsaltsalya" or "Zimb" of J. Bruce, 32, 121
Tsetse-fly (see also *Glossina*)
—— association of, with big game, questions as to species most closely connected with fly, 12, 15, 293, 295, 296
—— behaviour of, at night; sluggish when cool, 18
—— —— when sucking blood, 20
—— bionomics of, 1
—— blood-sucking habit common to both sexes, 23
—— —— time occupied in 22
—— chief foci of disease caused by, 300
—— dislike of, to human habitations and to animal excreta, 23
—— distinguishing characters of genus, 3, 60
—— discovery of species of, 2
Tsetse-fly, distinguished from *Stomoxys* and *Hæmatopota*, 3
—— doubtful whether all species are capable of conveying hæmatozoon, 2
—— earliest accounts of, 31
—— effects of bites, 21, 22
—— existence of, in districts destitute of big game, 13, 291, 293–296
—— fly-belts, extent and distribution, 6, 11
—— fondness of, for river-banks and neighbourhood of water, 7
—— formerly supposed to secrete a poison; in 1895 discovered to be the carrier of a hæmatozoon, v., 219, 226
—— genera most closely allied to, 59
—— general characters of, and distinction from other flies, 3
—— geographical distribution of, 28
—— historical survey of bionomics of, 31, and of systematic literature of, 50
—— larva of, 24
—— limitation of, to belts, explained, 11
—— localities in which found, fly-belts, 9, 11, 28, 300
—— mentioned as such first by Gordon Cumming (1850), 33, 125
—— mode of feeding, 21
—— —— flight, and noise thus produced, peculiarities of, 19
—— name, origin of, probably first applied by natives to flies generally 1 (note); note on origin of, by Capt. R. Crawshay, 309
—— native names for, 290
—— olfactory powers of, 19, 223
—— pain caused by bites of, 21, 245, 288
—— parts of animals usually attacked by, 22
—— period of day in which most active, 16, 288
—— probability of extinction, following destruction of big game, 288
—— proboscis of different species practically identical in structure, 106, 302
—— pupal stage of in Zululand species, 26
—— question as to manner in which effects of bite are produced, v
—— reproduction of, 23

Tsetse-fly, seasonal prevalence of, 15
—— systematic position of genus, 51, 53
—— technical description of genus and species, 60
—— term as used, generally equivalent to the genus, 2; onomatopoetic in origin, 1 (note)
—— three species known to exist in East Africa, 14
—— time taken in sucking its fill, 20
—— types of species examined by author, vii

U.

Uganda, absence of fly-disease in, 301
—— railway, results from, in extinction of big game, 49, 250; enables horses and mules to be transported through fly-belt for use in Ukamba, 249
Ungulates, Tsetse-fly disease not limited to, 263

W.

Walker, F. (1849), original description of *Stomoxys fuscus*, 51, 124; (1873), Central African blood-sucking flies, 153
Wandorobo or Donderobo fly, 305
Westwood, J. O. (1850), original description and figures of *Glossina morsitans*, *tachinoides* (= *palpalis*) and *tabaniformis* (= *fusca*), 32, 33, 34, 51, 125, 127, 128
Whyte, A. (1895), Report on botanical aspects of British Central Africa; the Tsetse an obstacle to agricultural enterprise, 219
Wiedemann, C. R. W. (1830), original description of genus *Glossina*, and of *Gl. longipalpis*, 51, 123
Wulp, F. M. van der (1884), an account of the Tsetse-fly, 41, 193; (1885), remarks at meeting of Nederlandsche Entomologische Vereeniging, 41, 193

Z.

Ziemann, Dr. H. (1902), the Tsetse-fly disease in Togo, 266
"Zimb," term mentioned by J. Bruce, perhaps designating Tsetse, 32, 121
Zululand, Tsetse-fly abundant in parts of, 30

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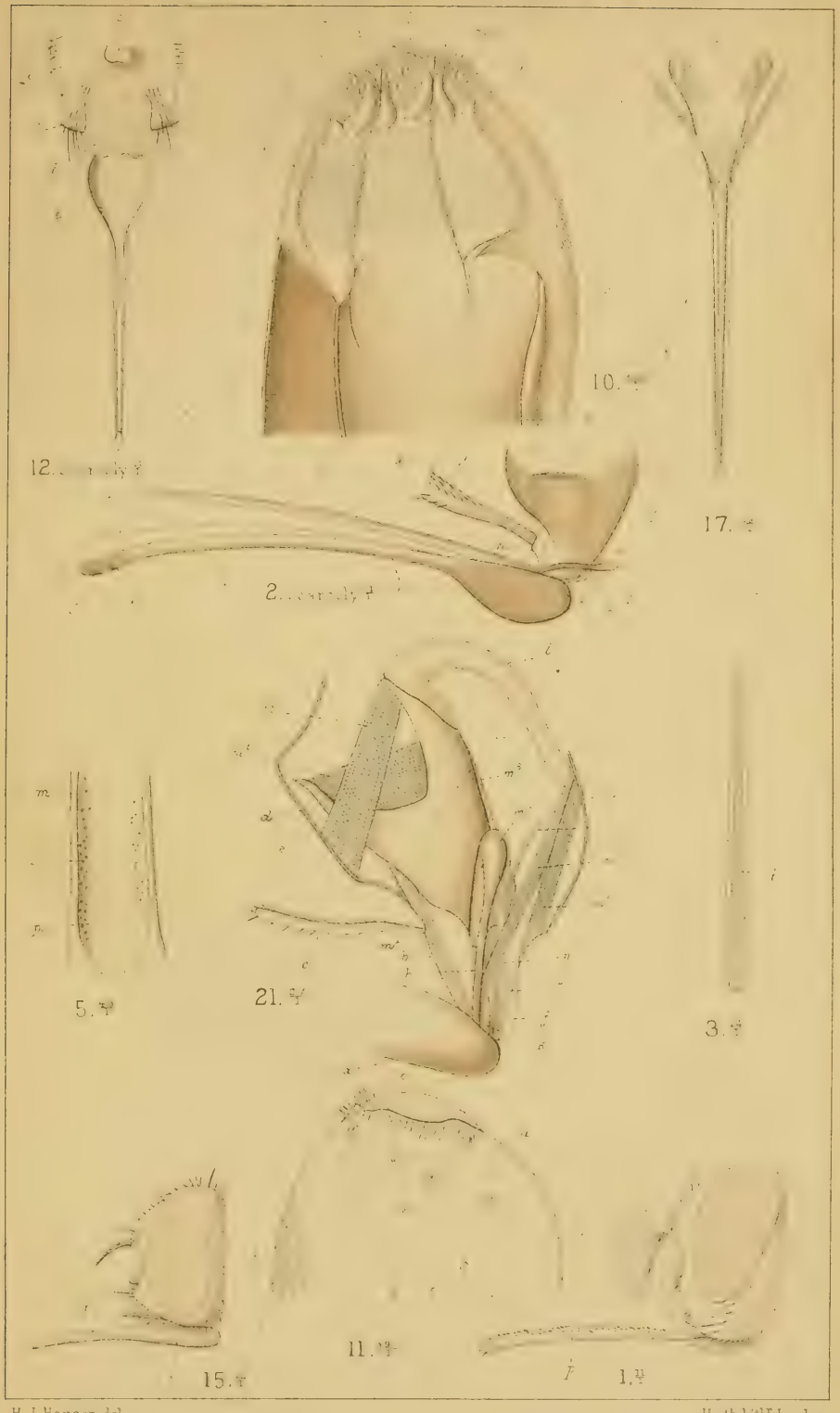

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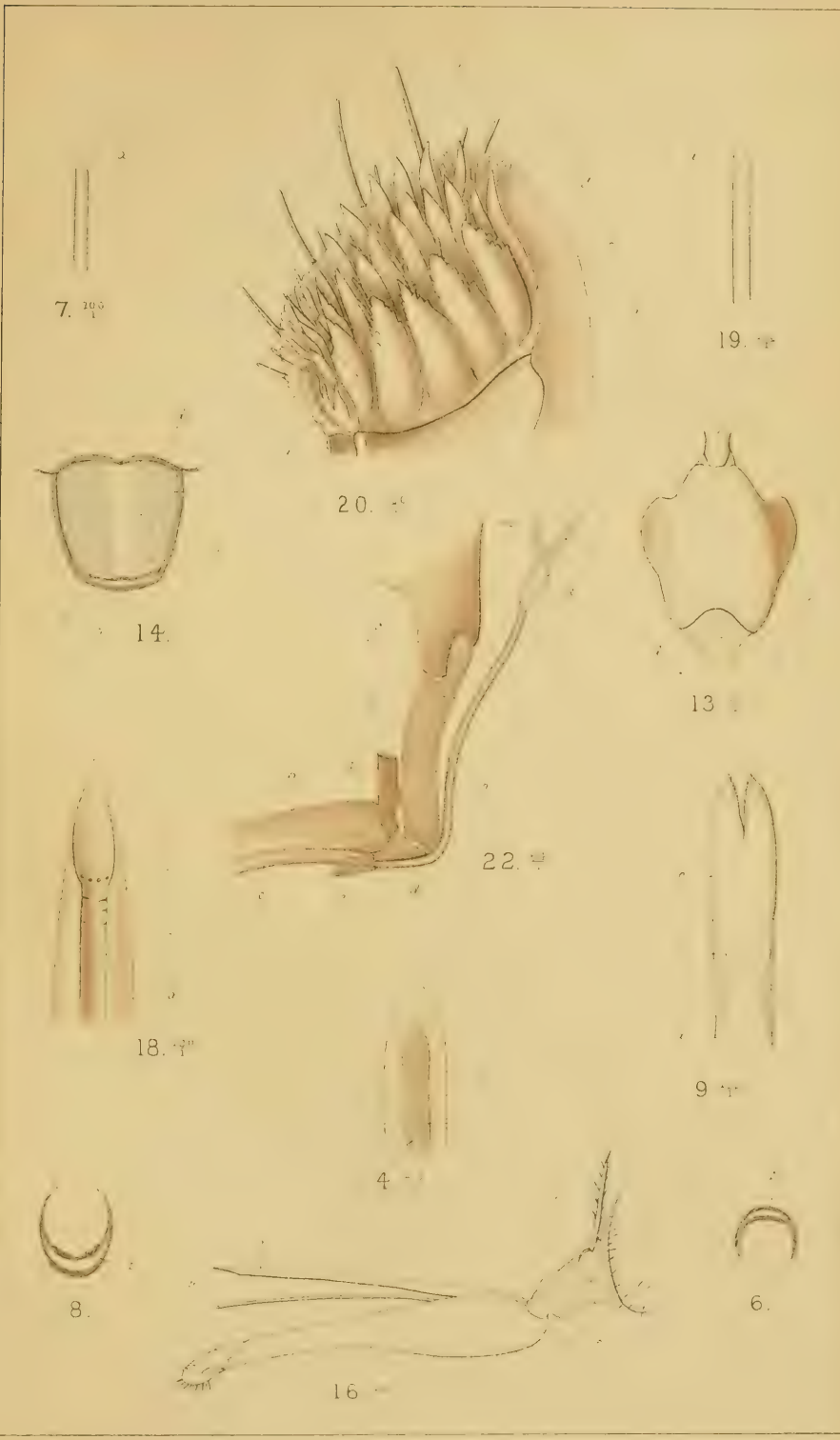

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